CPO/CP Series Installation, Operation and Maintenance Manual

SAMengineering

Customised Pump Solutions

SAM Engineering (Pty) Ltd.
24 Duncan Road, Lilianton,
Boksburg, South Africa
Tel: +27 (0) 11 823-4250
Fax: +27 (0) 11 823-4943
Email: pumps@sameng.co.za
www.sameng.co.za

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NOTE:
The information contained in this book is intended to assist operating personnel by providing information on the characteristics of the purchased equipment.

It does not relieve the user of their responsibility of using accepted engineering practices in the installation, operation, and maintenance of this equipment.

Any further questions, contact SAM Engineering (Pty) Ltd +27 (0) 11 823-4250.

INTRODUCTION

This manual is furnished to acquaint you with the procedures to install, operate and maintain a CPO/CP pump. Keep it handy for future reference. Additional information can be obtained from your SAM Engineering Sales Representative.

Equipment cannot operate well without proper care. To keep the unit at top efficiency, correct procedures for installation and maintenance must be followed. SAM Engineering can assist in the installation of equipment to ensure that maximum machine life can be attained with minimum downtime.

Your Sales Representative will also help with renewal of parts orders and problems requiring special attention.

PUMP IDENTIFICATION

PUMP NAMEPLATE

SAMCO PUMPS

MODEL		SER. NO.
FLOW (m^3/hr)		HEAD (m)
MAWP (KPag)	@ °C	IMP. DIA. (mm)
MOC		RPM
SG		HYDRO (kPag)

SAM Engineering (Pty) Ltd
Tel: +27 11 823-4250

CUSTOMER:
O/N
TAG NO.

BEARINGS
DE: NDE:

MODEL = Pump Model and Type

SER. NO. = Serial Number

FLOW (m^3/hr) = Design Flow Rate

HEAD (m) = Design Head

MAWP = Maximum Allowable Working Pressure @ Temperature in Deg C

IMP. DIA (mm) = Supplied Impeller Diameter

*MOC – Material of Construction

RPM = Operating Revolutions Per Minute

SG = Specific Gravity of Fluid Pumped

HYDRO = Hydro Test Pressure (kPa)

Permanent records are kept by SAM Engineering and filed by serial number.

*MOC = Material of Construction of pump shown in abbreviated form and in four parts.
EXAMPLE – CI/SS/CI/EN8 – where casing and stuff box are in Cast Iron, Impeller is in Stainless Steel, frame is in Cast Iron and shaft is in EN8.

TEMPORARY STORAGE

If the pump is not to be installed and operated soon after arrival, store it in a clean, dry location where there is slow, moderate changes in ambient temperature. Rotate the shaft every two weeks to coat the bearings with lubricant and to retard oxidation, corrosion, and to reduce the possibility of false brinelling of the bearings.

PUMP INSTALLATION

1. BASE PLATE SETTING (Before Piping)
By adding or removing shims under the base, level and plumb with the pump shaft and flanges. The base plate does not have to be level. Sufficient shims must be placed under the base so that when the anchor bolts are tightened, the base plate is not twisted in any way, making male alignment difficult or impossible.

2. SUCTION AND DISCHARGE PIPING
Piping should always be run to the pump. Both the suction and discharge piping should be independently supported near the pump and properly aligned so that no strain is transmitted to the pump when the flange bolts are tightened.

3. SHAFT ALIGNMENT
Although the pump has been factory aligned before shipment, it is important to re-do the shaft alignment after the pump has been installed. The alignment should be within the coupling supplier's tolerances. Should this not be available, align to within 0.1mm radially and axially, or contact SAM Engineering for further assistance.

PRE-START CHECKS

1. LUBRICATION
Before starting the pump, ensure that the oil level is in the centre of the sight glass. Grease lubricated pumps are factory lubricated before delivery and don't need lubrication.

2. VALVES
Ensure that all valves in the suction line are fully open. If there are external feed lines to the stuffing box or mechanical seal, ensure that the valves are open. Keep discharge valve closed.

3. PRIMING
Prime the pump properly.

4. LOCKING PLATES
Remove locking plates from mechanical seal.

5. STUFFING BOX
Turn on seal water to stuffing box.

6. MOTOR DIRECTION
IMPORTANT NOTE: It is very important to check the motor direction with the pump disconnected from the motor. Serious damage can result if the pump is operated with incorrect rotation.

7. COUPLING
Before the coupling is fitted, check that the pump is turning freely by hand.

STARTING THE PUMP

1. START
Start the pump.

2. DISCHARGE VALVE
When the pump is operating at full speed, open the discharge valve slowly.

OPERATING THE PUMP

1. NOISES
Listen for any strange noises coming from the pump. If such noises are identified, stop the pump and investigate.

2. VIBRATION
Feel the pump while it is running for any excessive vibration.

3. BEARING TEMPERATURES
On oil filled pumps, the bearing temperatures should not exceed 90°C.
On grease filled pumps, the bearing temperatures should not exceed 110°C.

4. ADJUSTMENTS
Make all pump output adjustments with the discharge valve. Do not throttle the suction line to adjust the pump output. Adjust gland packing to drip continuously.

SHUTTING DOWN THE PUMP

1. DISCHARGE VALVE
Close discharge valve slowly.

2. DRIVER
Shut down driver.

3. VALVES
Close valves as required.

4. DRAIN
Open drain valves as required.

DISASSEMBY INSTRUCTIONS

1. REMOVAL OF ROTATING ELEMENT FROM CASING

1.1 Lock off all electrical power to motor. Disconnect all piping to the stuffing box and other special piping. The casing may be left in process line assembled to the suction and discharge piping if repair or replacement is not required. Drain all liquid from the casing if necessary.

1.2 Remove the spacer portion of coupling. If V-Belt driven, remove belts.

1.3 Loosen and remove the nuts securing the frame to the casing. Swing the complete rotating element out and away from the casing using the lifting handle provided on frame. The casing gasket may then be removed followed by the complete rotating element to shop for further maintenance if required.

2. IMPELLER REMOVAL (Note: Impeller is threaded to shaft)

2.1 To remove the impeller, hold the shaft stationary at the drive end by suitable means. Turn the impeller in a counter clockwise direction, using a wrench on the hex provided on the impeller. If the impeller is tight, it can be tapped with a mallet or copper hammer on the vane tips to loosen it. Once loosened, the impeller should turn easily by hand. At no point in time should any heat be applied to loosen the impeller as this may cause an explosion.

3. STUFFING BOX REMOVAL

3.1 Packed Stuffing Box

Loosen and remove the screws securing the stuffing box cover to the frame and pull the stuffing box off the frame.

3.2 Mechanical Seal Stuffing Box

Loosen and remove the four nuts holding the mechanical seal gland plate to the stuffing box. Pull back the gland plate. Remove the screws securing the stuffing box to the frame. Pull the stuffing box cover from the frame, being careful not to damage the mechanical seal in any way. The seal rotating element and sleeve may be removed as an assembly. To remove the mechanical seal from the sleeve, loosen the set screw in the locking collar with an Allen wrench. Remove the seal gland plate then remove stationary seat from gland. Use care not to damage seal faces.

3.3 Cartridge Mechanical Seal Stuffing Box

As there are various arrangements available from mechanical seal suppliers, obtain more information on disassembly from the mechanical seal supplier.

3.4 Dynamic Seal Arrangement

Loosen and remove the screw securing the stuffing box cover to the frame and pull the stuffing box off the frame. Subsequently remove the sleeves, O-rings and expeller/s from the shaft. It is advisable to mark these parts in the way they are removed to simplify re-assembly.

4. BEARING FRAME DISASSEMBLY

4.1 Oil

Remove bottom drain plug to remove oil from the frame.

4.2 Deflectors

Loosen the grub screws and remove deflectors at the drive and non-drive ends.

4.3 Bearing House Removal

Loosen the Allen cap screws and remove them from the bearing housing. Loosen lock nuts on F15 and F35 bearing housings. Insert jacking screws of sufficient length to jack bearing housing complete with shaft out of the frame. On F45 and F65 frames, remove the shims.

4.4 Bearing Removal
On F15 and F35 frames, remove the circlip that holds the bearing inside the bearing housing. On F45 and F65 frames, remove the retaining ring screws and retaining ring. The bearing housing can now be pulled off the bearings.

On F15 and F35 frames, remove the circlip that holds the bearing to the shaft. On F45 and F65 frames, loosen the lock nut and remove the washer and lock nut from the shaft. The bearings can now be removed from the shaft with a standard bearing puller.

4.5 Oil Slingers
On F15 and F35 shafts, remove the oil slinger by pushing the two spring ends together and then slide the slinger off the shaft. On F45 and F65 shafts, loosen the two grub screws on the cast slinger and slide the slinger off the shaft. Make a note of the slinger to ensure that it goes back to the same position on re-assembly.

4.6 Lip Seals
Remove lip seals inside the bearing housing and frame with a suitable tool.

5. PARTS INSPECTION

5.1 Casing and Stuffing Box
All machined parts should be cleaned and inspected for excessive wear or corrosion.

5.2 Impeller
Check impeller vanes for signs of wear, breakage or corrosion.

5.3 Shaft Sleeve
Inspect shaft sleeve for excessive wear or grooves.

5.4 Shaft, Bearing Housing and Frame
Inspect for signs of wear or evidence that bearing races have turned on the shaft or inside the bearing housing and frame.

5.5 Worn Parts
Replace all parts mentioned above deemed not fit for service.

5.6 Bearings, Lip Seals, Gaskets and O-rings
Replace all.

ASSEMBLY INSTRUCTIONS

1. BEARING FRAME ASSEMBLY

1.1 Oil Slingers
Assemble oil slinger on the shaft in same position prior to removal. On F45 and F65 frames, tighten the grub screws.

1.2 Bearings
Use a suitable bearing heater and fit new bearings to shaft. On F15 and F35 frames, fit circlip onto shaft. On F45 and F65 frames, lock the washer and nut to the shaft. After tightening the nut, bend one of the lock washer tabs into the nut.

1.3 Lip Seals
Fit new lip seals to the bearing housing and frame with the lips facing outwards.

1.4 Bearing Housing
Tap the bearing housing over the drive end bearings and fit a circlip or retaining ring. Fit a new O-ring to the bearing housing.

1.5 Frame
Slide the complete bearing housing with shaft into the bearing frame and pull it in with the Allen cap screws.

1.6 Deflectors
Fit deflectors on both sides.

2. STUFFING BOX ASSEMBLY

2.1 Packed Stuffing Box
Push packing base ring into the bottom of stuffing box. At this stage, do not fit a PTFE lantern ring into the stuffing box. Fit a shaft sleeve to the shaft and fit a gland onto the shaft sleeve before fitting the stuffing box to the frame. Subsequently fit the stuffing box to the frame and tighten the screws that keep the stuffing box to the frame. The stuffing box can then be packed with three rings first, then slide the lantern ring over the shaft and insert another two packing rings. Packing joints must be staggered. Fit the gland follower and tighten the nuts by hand.

2.2 Mechanical Seal Stuffing Box
Fit the stationary seat to the clamp plate with an O-ring. Fit a shaft sleeve to the shaft and slide the clamp plate over the shaft sleeve. Subsequently fit the mechanical seal to the sleeve as per the seal supplier's instructions. Tighten the grub screws supplied with the retaining ring. Then fit the stuffing box to the frame and tighten the screws holding the stuffing box to the frame. Tighten the clamp plate to the stuffing box. For cartridge-type seals, refer to the seal supplier's installation instructions.

2.3 Dynamic Seals
For dynamic seal assembly, see drawings for one, two and three stage seals for the sequence. The stuffing box will always be the last item to be fitted to the frame.

3. IMPELLER ASSEMBLY

3.1 Fit Impeller
Fit the impeller to the shaft with a new O-ring. Tighten the impeller to ensure it is seated against the shaft sleeve. Jack the bearing housing so that there is a very small gap between the back of the impeller and the stuffing box. To do this, first jack the impeller up against the stuffing box until it stops turning, then jack the impeller slowly away from the stuffing box to the point where the impeller just starts turning freely. Subsequently lock the impeller in that position with two Allen cap screws and two jacking screws.

4. CASING ASSEMBLY

4.1 Casing Gaskets
Fit the casing gasket/s with a non-retaining sealant into the casing. Just fit one casing gasket at first.

4.2 Rotating Element
Fit the rotating element into the casing and tighten it loosely with 4 nuts. Should the shaft not turn, keep on fitting casing gaskets until the shaft rotates freely, then fit all nuts and tighten them.

4.3 Impeller Clearance

After all the nuts have been tightened, place a clock gauge on the back of the shaft and check the total float of the impeller inside the casing by jacking the bearing housing backwards and forwards in the frame. The total float should be a minimum of 0.5mm for pumps operating at a maximum of 200°C. If not, open the casing and fit another casing gasket.

Once the total float is correct, you can adjust the working clearance of the impeller. Jack the impeller against the casing until it stops turning, then jack the impeller slowly away from the casing until it begins turning freely. Adjust the clock gauge to zero and then jack the impeller a further 0.25-0.30mm away from the casing and lock the bearing housing in that position with the grub screws and Allen cap screws. If there are lock nuts, tighten them against the bearing housing. For the F45 and F65 frames, fit the appropriate amount of shims and then measure the clearance between the impeller and the casing with a feeler gauge. Ensure that the pump turns freely by hand after adjusting the clearance.

For pumps operating above 200°C, the total float must be 0.8mm and the impeller clearance 0.4mm.

5. DEFLECTORS

Deflector Adjustment

Push the deflectors into position until they start rubbing, then pull them away between 1 and 2mm and lock them in that position with the grub screws supplied. Once again, make sure the pump is turning freely and listen for any catching noises.

6. OIL FILL

Fill the pump with correct grade oil until the oil level is in the centre of the sight glass.

6.1 Oil Lubrication

Recommended oil grade is SAE 10. Temperatures should not exceed 90°C. Although SAE 10 is preferred, if it is not available, an SAE 20 or SAE 30 can be used. For pumps pumping liquid at temperatures above 200°C, use a synthetic oil type. Change the oil after 4000 hours of operation or once a year, whichever comes first.
Keep oil level in centre of sight glass.

7. GREASE LUBRICATION

Pumps are factory lubricated before delivery and need only be lubricated after 8000 hours of operation with ±30 grams of grease each side.

Recommended grease: Total ALTIS EM2 or any equivalent polyurea grease. If a polyurea grease is not available, the bearings can be packed with a good lithium based grease.

NB: Do not mix greases.

Operating temperatures should not exceed 110°C.

IMPORTANT NOTE: Do not over-grease bearings as this will cause a rapid rise in operating temperature and lead to premature failure of the bearings.

FRAME SIZES

PUMP SIZE CPO	PUMP SIZE CP	FRAME SIZE
CPO 1x¾x6 CPO 1.5x1x6 CPO 3x1.5x6 CPO 3x2x6 CPO 1.5x1x8	CP 30-150 CP 40-150 CP 50-150 CP 30-200	F15
CPO 3x1.5x8.5 CPO 3x2x8.5 CPO 4x3x8.5 CPO 6x4x8.5 CPO 2x1x10 CPO 6x4x10 CPO 3x1.5x11 CPO 3x2x11 CPO 4x3x11 CPO 3x1.5x13 CPO 3x2x13 CPO 4x3x13 CPO 6x4x13	CP 40-216 CP 50-216 CP 80-216 CP100-216 CP 30-250 CP 100-250 CP 40-280 CP 50-280 CP 80-280 CP 40-330 CP 50-330 CP 80-330 CP 100-330	F35
CPO 8x6x13	CP 150-330	F45
CPO 8x6x15 CPO 10x8x15		F65

TORQUE VALUES FOR CASING TO STUFFING BOX AND BEARING

SIZE	N.m
M8 M10 M12 M16 M20	30 60 100 240 470

GENERAL MAINTENANCE

Operating conditions vary so widely that to recommend one schedule of preventative maintenance for all centrifugal pumps is not possible. However, it is imperative that some sort of regular inspection is planned and followed. We suggest a permanent record be kept of the periodic inspections and maintenance performed on your pump. This recognition of maintenance procedure will keep your pump in good working condition, and prevent costly breakdowns.

One of the best rules to follow in the proper maintenance of your centrifugal pump is to keep a record of actual operating hours. Then, after a predetermined period of operation has elapsed, the pump should be given a thorough inspection. The length of this operating period will vary with different applications, and can only be determined from experience. New equipment, however, should be examined after a relatively short period of operation. The next inspection period can be lengthened somewhat. This system can be followed until a maximum period of operation is reached which should be considered the operating schedule between inspections.

MAINTENANCE OF PUMP DUE TO FLOOD DAMAGE

The servicing of centrifugal pumps after a flooded condition is a comparatively simple matter under normal conditions.

Bearings are a primary concern on pumping units. First, dismantle the bearings; clean and inspect them for any rusted or badly worn surfaces. If bearings are free from rust and wear, re-assemble and re-lubricate them with one of the recommended pump lubricants. Depending on the length of time the pump has remained in the flooded area, it is unlikely that bearing replacement is necessary; however, in the event that rust or worn surfaces appear, it may be necessary to replace the bearings.

Next, inspect the stuffing box, and clean out any foreign matter that might clog the box. Packing that appears to be worn, or no longer regulates leakage properly should be replaced. Mechanical seals should be cleaned and thoroughly flushed.

Couplings should be dismantled and thoroughly cleaned. Lubricate the coupling with one of the coupling manufacturer's recommended lubricants where required.

Any pump that is properly sealed at all joints and connected to both the suction and discharge should exclude outside liquid. Therefore, it should not be necessary to go beyond the bearings, stuffing box and coupling when servicing the pump.

BEARING LUBRICATION — GREASE

Grease lubricated ball bearings are packed with grease at the factory and ordinarily will require no attention before starting, provided the pump has been stored in a clean, dry place prior to its first operation. The bearings should be observed in the first hour or so after the pump has been started to see that they are operating properly.

The importance of proper lubrication cannot be over emphasised. It is difficult to say how often a bearing should be greased, since this depends on the conditions of operation. It is recommended that one ounce of grease is added at regular intervals, however, it is equally important to avoid adding too much grease. For average operating conditions, it is recommended that one ounce of grease be added at intervals of three to six months, using only clean grease. It is advised that the unit is stopped while grease is added to avoid overloading.

NOTE: Excess grease is the most common cause of overheating.

The bearing frame should be kept clean, since any contamination of foreign matter which gets into the housing will destroy bearings in a short time. When cleaning bearings, use a bearing cleaning solvent or an industrial cleaning solvent. Do not use gasoline. Use lint free cloths. Do not use waste rags.

A regular ball bearing grease should be used, but a standard commercial vaseline can be substituted if necessary.

Do not use graphite. A no. 1 or 2 grease is generally satisfactory for operation at ordinary temperatures – the lighter grease for operation at high speed or low room temperature.

Mineral greases with a soda soap base are recommended. Grease made from animal or vegetable oils are not recommended due to the danger of deterioration and forming of acid. Most of the leading oil companies have special bearing greases which are satisfactory. For specific recommendations, consult the factory.

The maximum desirable operating temperature for ball bearings is 82°C. Should the temperature of the bearing frame rise above 82°C, the pump should be shut down to determine the cause.

Grease lubricated bearings should not be used where temperature of the pumped liquid exceeds 180°C.

NOTE: A bearing frame which feels hot to the touch is not necessarily running hot. Check with an accurate temperature measuring device to be sure.

BEARING LUBRICATION — OIL

The oil-lubricated pumps may have an oiling ring, in which the oil is picked up from the reservoir by a rotating oil ring and deposited on the shaft and bearings inside the bearing housing; or they may have an oil slinger, which creates a shower of fine droplets over the entire interior of the bearing cavity.

After the pump has been installed, flush the bearing housing to remove dirt, grit and other impurities that may have entered the bearing housing during shipment or erection, then refill the bearing housing with proper lubricant. The oil level to be maintained is midway in the sight glass.

Experience shows that oils meeting the s pecifications below will provide satisfactory lubrication. These oils can be furnished by all major oil companies. It is the responsibility of the oil vendor to supply a suitable lubricant.

(1) Saybolt viscosity at 38°C	150-200 SSU
(2) Saybolt viscosity at 99°C	43 SSU
(3) Viscosity index, minimum	95
(4) API gravity	28 - 33
(5) Pour point, maximum	+93°C
(6) Flash point, minimum	200°

(7) Additives: Rust and Oxidation inhibitors

NOTE: Oils from different suppliers should not be mixed.

The oil should be well refined, good grade, straight cut, filtered mineral oil. It must be free from water, sediment, resin, soaps, acid and fillers of any kind. It should also be non-foaming with a viscosity of about 150-200 SSU at 38°C. (approximately SAE 20).

In installations with moderate temperature changes, humidity and dirt, the oil should be changed approximately every 160 hours of operation. The oil should be inspected to determine the operating period before the next oil change. Oil change periods may be increased up to 2000-4000 hours based on an 8000-hour year. Check the oil frequently for moisture, dirt or signs of 'breakdown'.

CAUTION: DO NOT OVER-OIL; THIS CAUSES THE BEARINGS TO RUN HOT. THE MAXIMUM DESIRABLE OPERATING TEMPERATURE FOR BALL BEARINGS IS 82°C. SHOULD THE TEMPERATURE OF THE BEARING FRAME EXCEED 82°C (MEASURED BY THERMOMETER), SHUT DOWN PUMP TO DETERMINE THE CAUSE.

STUFFING BOX

The standard stuffing box consists of rings of packing, (See assembly section for number of rings) a seal cage and a gland. A shaft sleeve which extends through the box and under the gland is normally provided to protect the shaft.

A tapped hole is supplied in the stuffing box directly over the seal cage to introduce a clean, clear sealing medium. The stuffing box must at all times be supplied with sealing liquid at a high enough pressure to keep the box free from foreign matter, which would quickly destroy the packing and score the shaft sleeve.

Water Lubrication

Only a sufficient volume of sealing liquid is required to create a definite direction of flow from the stuffing box inward to the pump casing, but the pressure is important. Apply seal water at a rate of 2-4l/m, at 35-70kPa above stuffing box operating pressure.

We recommend that piping supplying sealing liquid to the stuffing box be sized to supply a sufficient volume of water at the required pressure, based on the location of the pump (or pumps) with respect to the liquid source. A small pipe can be utilised for the connection to the stuffing box. A valve should be installed to adjust and regulate the sealing liquid and a gauge installed to check pressure to the box.

External sealing liquid should be adjusted to the point where the packing runs only slightly warm, with a very slow drip from the stuffing box. Excess pressure from an external source can be very destructive to packing. More pressure is required for abrasive slurries than for clear liquids. Examination of the leakage will indicate whether to increase or decrease external pressure. If slurry is present in the leakage, increase the pressure until only clear liquid drips from the box. If the drippage is corrosive or harmful to personnel, it should be collected and piped away.

A common error is to open the external piping valve wide and then control the drippage by tightening the packing gland. In actuality, a combination of both adjustments is essential to arrive at the optimum condition. The life of packing and sleeves depends on this careful control more than any other factor.

Grease Lubrication

Pump stuffing boxes are also suitable for grease lubrication. Several types of grease lubricators are available. When using a grease lubricator, grease pressure to the stuffing box should be equal to the pump discharge pressure.

Packing

Pumps are not packed before shipment, unless otherwise requested. If packed, packing used is quality branded standard material. Before the pump is put into operation, check the condition of the packing. If the pump is installed within 60 days after shipment, the packing will be in good condition with a sufficient supply of lubrication. If the pump is stored for a longer period, it may be necessary to repack the stuffing box. In all cases, however, we recommend an inspection of the packing before the pump is started.

Fibre Packing

The standard packing is a soft, square asbestos, impregnated with oil and graphite. A soft well-lubricated packing reduces stuffing box resistance and prevents excessive wear on the shaft or shaft sleeve. Many brands of packing on the market have the desired qualities. For specific recommendations, consult the factory.

When a pump with fibre packing is first started, it is advisable to have the packing slightly loose without causing an air leak. As the pump runs in, gradually tighten the gland bolts evenly. The gland should never be drawn to the point where packing is compressed too tightly, and no leakage occurs. This will cause the packing to burn, score the shaft or shaft sleeve, and prevent liquid from circulating through the stuffing box, cooling the packing. The stuffing box is improperly packed or adjusted if friction in the box prevents turning the rotating element by hand. A properly operated packed stuffing box should run lukewarm with a slow drip of sealing liquid. After the pump has been in operation for some time and the packing has been completely run-in, drippage from the stuffing box should be at least 40 to 60 drops per minute. This will indicate proper packing and shaft sleeve lubrication and cooling.

NOTE: Eccentric operation of the shaft, or sleeve, through the packing could result in excess leakage that cannot be compensated for. Correction of this defect is very important.

Packing should be checked frequently and replaced as indicated by service. Six months might be a reasonable expected life, depending on operating conditions. It is impossible to give any exact predictions. A packing tool may be used to remove all old packing from the stuffing box. Never reuse old and lifeless packing or merely add some new rings. Make sure that the stuffing box is thoroughly cleaned before new packing is installed. Also check the condition of the shaft or sleeve for possible scoring or eccentricity, making replacements where necessary.

New packing should be placed carefully into the stuffing box. If moulded rings are used, the rings should be opened sideways and the joints pushed into the stuffing box first. The rings are installed one at a time, each ring seated firmly, and the joints staggered so that they are not in line. The joints should be kept toward the upper side of the shaft and should be at about a 90° angle from each preceding joint.

If coil packing is used, cut one ring to accurate size with either a butt or mitered joint. An accurately cut butt joint is superior to a poor fitting mitered joint. Fit the ring over the shaft to assure proper length, then remove and cut all other rings to the first sample. When the rings are placed around the shaft, a tight joint should be formed. Place the first ring in the bottom of the stuffing box, then install each succeeding ring, staggering the joints as described above and making sure each ring is firmly seated. Make sure the seal cage is properly located in the stuffing box under the sealing water inlet. The function of the seal cage is to establish a liquid seal around the shaft, prevent leakage of air through the stuffing box, and lubricate the packing. If it is not properly located, it serves no purpose.

MECHANICAL SHAFT SEALS

General

A mechanical shaft seal is supplied in place of a packed stuffing box where specifically requested. On certain applications, mechanical seals are preferred over packing because of better sealing qualities and longer serviceability. Leakage is eliminated when a seal is properly installed, and normally the life of the seal is much greater than that of packing on similar applications.

General instructions for operation of the various mechanical sealing arrangements are included below. It is not feasible to include detailed instructions for all mechanical seals in this booklet because of the almost unlimited number of possible combinations and arrangements. Instead, seal manufacturer's instructions will be included as a separate supplement to this book where required.

1. Mechanical seals are precision products and should be treated with care. Use special care when handling seals. Clean oil and clean parts are essential to prevent scratching the finely lapped sealing faces. Even light scratches on these faces could result in leaky seals.

2. Normally, mechanical seals require no adjustment or maintenance except routine replacement of worn or broken parts.

3. A mechanical seal which has been used should not be put back into service until the sealing faces have been replaced or re-lapped. (Re-lapping is generally economical only in seals two inches in size and above.)

Four important rules which should always be followed for optimum seal life are:

1. Keep the seal faces as clean as possible

2. Keep the seal as cool as possible

3. Assure that the seal always has proper lubrication

4. If the seal is lubricated with filtered fluid, clean the filter frequently

CLEANING WITHOUT DISMANTLING PUMP

We recommend that an increasing suction nozzle, bolted to the suction flange, be used. (If this is not done, a short section of pipe designed so that it can be readily dropped out of the line can be installed adjacent to the suction flange.) With this arrangement, any matter clogging the impeller is accessible by removing the nozzle (or pipe section).

The suction nozzle should be equipped with a handhole with removable cover and a pipe tap for injecting high-pressure clean out water into the pump. This high-pressure water (up to 5.5 bar) can be injected to flush out any matter clogging the impeller or water passages. The water should be applied only with the suction valve closed.

Other cleaning methods include running an auger into the pump through the clean out hole in the suction nozzle, or through the casing handhole. This should free any clogging in the impeller eye.

If the pump cannot be freed of clogging after the above methods have been tried, dismantle the unit as previously described to locate the trouble.

MAINTENANCE TIME TABLE

Every Month

Check bearing temperature with a thermometer, not by hand. If bearings are running hot (over 82°C), it may be the result of too much lubricant. If changing the lubricant does not correct the condition, disassemble and inspect the bearings.

Every 3 Months

Check grease lubricated bearings for saponification. This condition is usually incurred by the infiltration of water or other fluid past the bearing shaft seals and can be identified immediately upon inspection, since it gives the grease a whitish colour. Wash out the bearings with a clean industrial solvent and replace the grease with the proper type as recommended.

Every 6 Months

Check the packing and replace if necessary. Use the grade recommended. Be sure the seal cages are centred in the stuffing box at the entrance of the stuffing box piping connection.

Check the shaft or shaft sleeve for scoring. Scoring accelerates packing wear.

Check alignment of the pump and motor. Shim up units if necessary. If misalignment recurs frequently, inspect the entire piping system. Unbolt piping at suction and discharge flanges to see if it springs away, thereby indicating strain on the casing. Inspect all piping supports for soundness and effective support of load.

Every Year

Remove the rotating element. Inspect thoroughly for wear and order replacement parts if necessary.

Check wearing clearances.

Remove any deposit or scaling. Clean out stuffing box piping.

Measure total dynamic suction and discharge head as a test of pipe connection. Record the figures and compare them with the figures of the last test. This is important especially where the fluid being pumped tends to form a deposit on internal surfaces. Inspect foot valves and check valves, especially the check valve which safeguards against water hammer when the pump stops. A faulty foot or check valve will reflect also in poor performance of the pump while in operation.

Between regular maintenance inspections, be alert for signs of motor or pump trouble. Common symptoms are listed below. Correct any trouble immediately to AVOID COSTLY REPAIR AND SHUTDOWN.

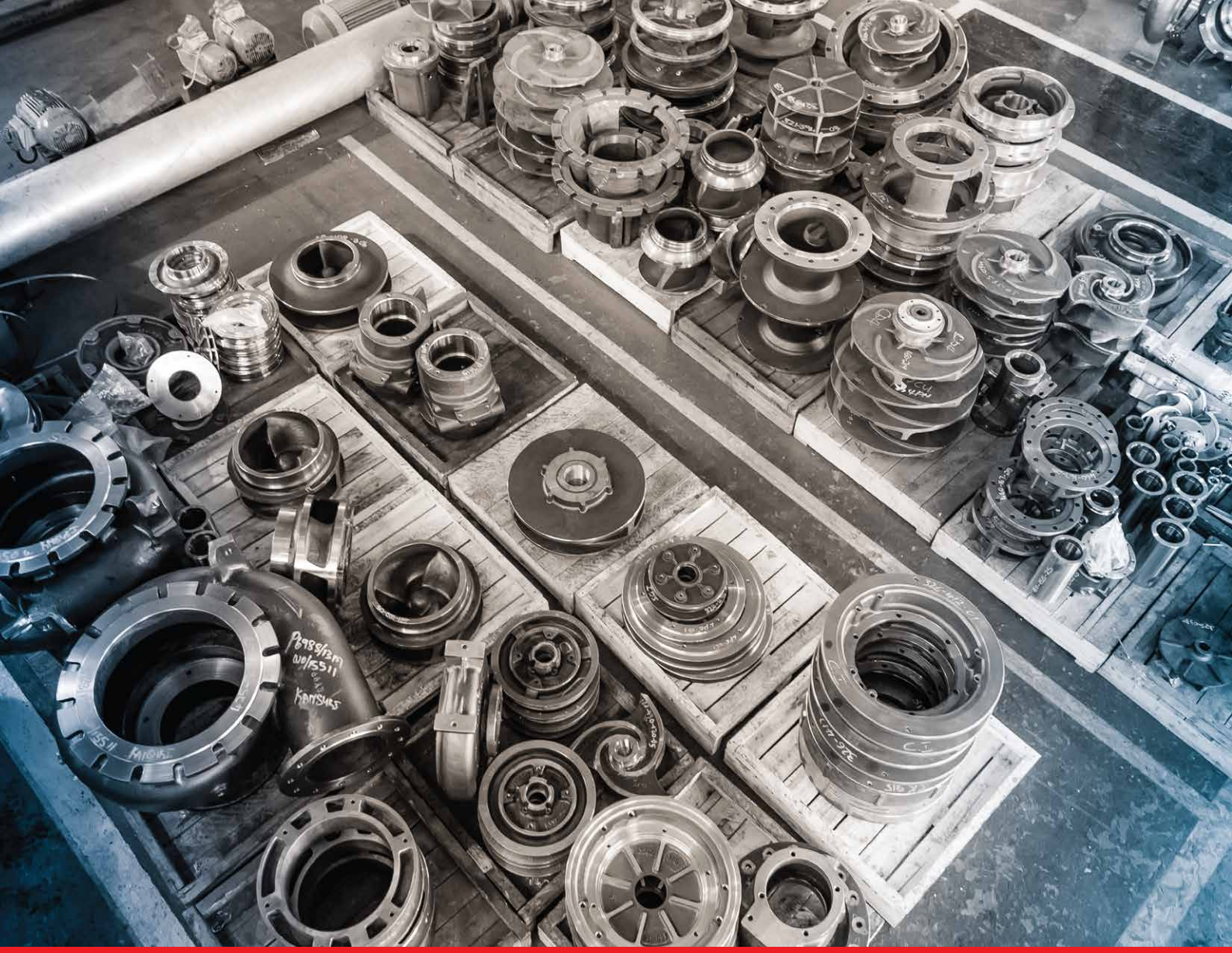
No liquid delivered	
CAUSES	**CURES**
1. Lack of prime	Fill pump and suction pipe completely with liquid.
2. Loss of prime	Check for leaks in suction pipe joints and fittings; vent casing to remove accumulated air.
3. Suction lift too high	If no obstruction at inlet, check for pipe friction losses. However, static lift may be too great. Measure with mercury column or vacuum gauge while pump operates. If static lift is too high, liquid to be pumped must be raised or pump lowered.
4. Discharge system head too high	Check pipe friction losses. Larger discharge piping may correct condition. Check that valves are wide open.
5. Speed too low	Check whether motor is directly across-the-line and receiving full voltage. Alternatively, frequency may be too low; motor may have an open phase.
6. Wrong direction of rotation	Check motor rotation with directional arrow on pump casing. Wrong rotation will cause pump damage.
7. Impeller completely plugged	Dismantle pump or use piping handhole to clean impeller.

No liquid delivered	
CAUSES	**CURES**
8. Air leaks in suction piping	If liquid pumped is water or other non-explosive material, and explosive gas or dust is not present, test flanges for leakage with a flame or match. For such liquids as gasoline, suction line can be tested by shutting off or plugging inlet and putting line under pressure. A gauge will indicate a leak with a drop of pressure.
9. Air leaks in stuffing box	Increase seal lubricant pressure to above atmosphere.
10. Speed too low	See item 5.
11. Discharge system head too high	See item 4.
12. Suction lift too high	See item 3.
13. Impeller partially plugged	See item 7.
14. Cavitation; insufficient NPSH (depending on installation)	a. Increase positive suction head on pump by lowering pump or increasing suction pipe size or raising fluid level. b. Sub-cool suction piping at inlet to lower entering liquid temperature. c. Pressurise suction vessel.
15. Defective impeller	Inspect impeller. Replace if damaged or vane sections badly eroded.
16. Defective packing	Replace packing and sleeves if badly worn.
17. Foot valve too small or partially obstructed	Area through ports of valve should be at least as large as area of suction pipe, preferably 1½ times. If strainer is used, net clear area should be 3 to 4 times area of suction pipe.
18. Suction inlet not immersed deep enough	If inlet cannot be lowered, or if eddies through which air is sucked persist when it is lowered, chain a board to suction pipe. It will be drawn into eddies, smothering the vortex.
19. Wrong direction of rotation	Compare rotation of motor with directional arrow on pump casing. Wrong rotation will cause pump damage.
20. Too small impeller diameter (probable cause if none of the above)	Check with factory to see if a larger impeller can be used; otherwise, cut pipe losses or increase speed, or both, as needed. Be careful not to seriously overload drive.

Not enough pressure	
CAUSES	**CURES**
21. Speed too low	See item 5.
22. Air leaks in suction piping	See item 8.
23. Mechanical defects	See items 15, 16, and 17.
24. Obstruction in liquid passages	Dismantle pump and inspect passages of impeller and casing. Remove obstruction.
25. Air or gases in liquid (Test in laboratory, reducing pressure on liquid to pressure in suction line. Watch for bubble formation.)	May be possible to overrate pump to the point where it will provide adequate pressure despite condition. It is better to provide gas separation chamber on suction line near pump, and periodically exhaust accumulated gas. See item 14.
26. Excessive impeller clearance	Adjust impeller clearance.
27. Too small impeller diameter (probable cause if none of the above.)	See item 20.

Pump operates for a short time, then stops	
CAUSES	**CURES**
28. Incomplete priming	Free pump, piping and valves of all air. If high points in suction line prevent this, they need correcting. See page 5.
29. Suction lift too high	See item 3.
30. Air leaks in suction piping	See item 8.
31. Air leaks in stuffing box	See item 9.
32. Air or gases in liquid	See item 25.

No liquid delivered	
CAUSES	**CURES**
33. Head lower than rating; thereby pumping too much liquid	Machine impeller's OD to size advised by factory.
34. Cavitation	See item 14.
35. Mechanical defects	See items 15, 16, and 17.
36. Suction inlet not immersed enough	See item 18.
37. Liquid heavier (in either viscosity or specific gravity) than allowed for	Use larger driver. Consult factory for recommended size. Test liquid for viscosity and specific gravity. See item 6.
38. Wrong direction of rotation	Release gland pressure. Tighten reasonably. If sealing liquid does not flow while pump operates, replace packing. If packing is wearing too quickly, replace scored shaft sleeves and keep liquid seeping for lubrication.
39. Stuffing box too tight (Packing)	Check alignment. Examine pump for friction between impeller and casing. Replace damaged parts. Check for pipe strain.
40. Casing distorted by excessive strains from suction or dis-charge piping	Check alignment. Examine pump for friction between impeller and casing. Replace damaged parts. Check for pipe strain.
41. Shaft bent due to damage - through shipment, operation, or overhaul	Dismantle pump and inspect shaft.
42. Mechanical failure of critical pump parts	Check bearings and impeller for damage. Any irregularities in these parts will cause a drag on the shaft.
43. Misalignment	Realign pump and driver.
44. Speed may be too high (brake hp of pump varies as the cube of the speed; therefore any increase in speed means considerable increase in power demand)	Check voltage on motor.
45. Electrical defects	The voltage and frequency of the electrical current may be lower than that for which the motor was built: or there may be defects in the motor. The motor may not be ventilated properly due to a poor location.
46. Mechanical defects in turbine, engine, or other type of drive exclusive of motor	If trouble cannot be located, consult factory.



SAMengineering

Customised Pump Solutions

SAM Engineering (Pty) Ltd.
24 Duncan Road, Lilianton, Boksburg, South Africa
Tel: +27 (0) 11 823-4250 | Fax: +27 (0) 11 823-4943
Email: pumps@sameng.co.za
www.sameng.co.za