Kestner Chemical Pumps Ltd

Operation and Maintenance Manual

‘MHC’ Horizontal Close Coupled Pumps

KESTNER CHEMICAL PUMPS LIMITED

INSTALLATION AND INITIAL START-UP INSTRUCTIONS
HORIZONTAL CENTRIFUGAL PUMPS

PLEASE READ CAREFULLY BEFORE START UP

CHECK AS FOLLOWS:-

A) **ELECTRICAL SUPPLY**: The supply voltage against the information on the electric motor nameplate. The phasing of the supply is in accordance with the information plate on the motor.

Check the direction of rotation of the motor before coupling the pump to the motor. (MH and KSI PUMPS). This must agree with the direction arrow indicated on the bearing housing. In order to prevent serious damage to the pump which would occur due to incorrect rotation, the pump is supplied with the coupling bolts reversed or the coupling tyre disconnected. Only after checking the rotation, may these bolts or the tyre be fitted correctly in accordance with the instructions provided and correctly tightened.

B) **OIL LEVEL (MH and KSI PUMPS):** The constant level oiler should be filled with the correct grade of lubricating oil as specified in the relevant table in the maintenance instructions. The initial filling of the bearing housing may require more than one filling of the constant level oiler.

C) **SEAL FLUSHING:** Certain types of mechanical seal require a water, product or other liquid flushing supply. This connection must be made and the flush checked to ensure the specified flowrate and pressure are available before start-up. Consider using 'Lockshield' type valves to ensure that the sealant flush supply cannot be interrupted during pump operation or damage to the seals will result.

D) **MECHANICAL SEAL COMPRESSION:** This and the clamping of the seal to the impeller shaft must be checked before start-up. Where cartridge type mechanical seals have been used the settings are pre-set, and it is only necessary to ensure that the clamping grubscrews are fully tightened. (See also separate sheet for mechanical seal notes).

E) **ALIGNMENT:** The alignment of the electric motor and pump should be checked, also make sure that there are no excessive pipe loadings which could pull the pump out of alignment. For the same reasons, check that the bedplate feet are properly packed on the foundations before tightening the holding down bolts. It is beneficial to use flexible compensators capable of accepting axial movement and compatible with the pumped fluid. These should be mounted as close as possible and in-line with the pump suction and discharge branches.

F) **START-UP:** The pump must be primed with liquor before starting, it is detrimental to the pump to run at 'shut valve' with no flow through the pump for a period exceeding two minutes.

G) **LONG TERM STORAGE:** The pump unit should be rotated by hand at least weekly.

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FAILURE TO PUMP

In the unlikely event of the pump failing to pump correctly the following points should be checked.

(A) Air Leaks into the suction pipework.

(B) Air lock in the pump casing due to incorrect priming.

(C) Suction pipework may be blocked with solid material.

(D) Pump speed possibly incorrect due to faulty electrical connection.

ROUTINE CHECKS DURING NORMAL RUNNING

(A) Excessive noise or vibration.

(B) Bearing temperature.

(C) Oil level (MH and KSI Pumps).

(D) Mechanical seal leakage (see also separate notes on mechanical seal operation).

GENERAL POINTS TO NOTE ON INITIAL INSTALLATION

(A) Pipework should not allow air pockets to form in the suction pipework.

(B) To ensure a smooth liquor flow into the pump the number of bends, valves and other obstructions etc, should be kept to a minimum. Suction pipework should be equal to or larger than that of the pump suction diameter.

(C) There must be no excessive 'springing' of the connecting pipework as this causes excess mechanical loading on the pump casing. Pipework must be amply supported.

(D) It is good practice to install a control valve close to the pump on the delivery side to allow for delivery control adjustments. Control of the pump flow should not be effected by a valve in the suction pipework.

(E) The Keebush and Keeplus pumps should have a 3mm thick rubber joints, Shore hardness 50-70 fitted between the pump branches and connecting pipework. The rubber must be compatible with the pumped fluid.

(F) The metal pumps should have C.A.F. jointing gasket material 1-2mm thick between the pump branches and connecting pipework. The joint must be compatible with the pumped fluid.

(G) The pump branch flanges, seal clamp plate and pump casing fasteners should be tightened to torque figures given in the maintenance instructions.

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CONSTRUCTION OF THE MHC PUMP

PLEASE READ CAREFULLY BEFORE OPERATION

GENERAL

1.1 The MHC is designed as a metric, horizontal, close coupled pump manufactured in a variety of materials both metallic and plastic. The same general construction is used for all the MHC pumps with only minor differences to suit the properties of the materials of construction. Metallic pumps are fitted with fully shrouded impellers, while KEEPLUS and KEEBUSH pumps are fitted with semi-open impellers. The use of back vanes on the latter enables the axial thrust on the motor bearings to be minimized. Within each size of pump all non wetted parts are identical and complete sets of wetted end parts of different materials can be interchanged. This design feature gives advantages in the spares inventory both in the factory and in service. Thus a customer who is using pumps of different materials can reduce his spares stock of non-wetted components. This pump utilizes standard mechanical shaft seals and a variety of sealing arrangements can be offered. Item numbers used in the following sections refer to those from sectional arrangement drawing No. L 15609.

ROTATING ASSEMBLY

1.2 Comprises of the impeller (6) keyed and grub-screwed direct to the motor output shaft (in the case of some plastic impellers this might consist of a composite component ie. Metal insert moulded or bonded into the plastic impeller) and the rotating seal assembly.

THE PUMP CASING

1.3 Comprises mounting bracket (10), backplate (5), volute casing (8) and clamp plate (9) which are clamped together by means of 8 clamp bolts (14). The backplate (5) provides the housing for the stationary seat of the mechanical seal.

DISMANTLING (CRANE TYPE 10T MECHANICAL) SEAL DRG NO. L 15726

1.4 If the motor and mounting bracket (10) are to be left in situ, a sufficient length of suction piping must be removed to enable the volute casing (1) to be removed clear of the impeller (4). This length varies with the size of pump, but 0.2m will generally be sufficient in all cases. Otherwise break the suction and discharge joints at the connections to the system pipework, disconnect the electrical connections and remove the pump and motor complete.

Slacken clamp bolts (14) evenly and remove. Carefully break the joint between the volute casing (1) and the backplate (6). The volute casing (1) may now be removed thus exposing the impeller (4). Remove the joint ring (7) and impeller retaining set screw (12) completely. The impeller (4) can now be drawn off the motor shaft complete with the Crane type 10T seal and pump backplate (6). Slacken the two clamping nuts which retain the seal rotating

components onto the impeller sleeve. The impeller (4) may now be pushed right through the seal components. It is very important to ensure that the impeller retaining set screw is completely removed before pushing the impeller through the seal, otherwise there is a danger of damaging the bore of the PTFE bellows. For more information on seal constructions and setting the reader is referred to the Crane leaflet enclosed with these instructions.

The stationary seat of the seal (8) is released by removing the nuts (13) and then the seal clamp plate (9).

RE-ASSEMBLY (CRANE TYPE 10T MECHANICAL SEAL) DRG NO. L 15726

1.5 In general re-assemble in reverse order to previous section. The diametral clearances are fixed by the spigot location of the pump components and no adjustment is necessary or provided. However, the axial clearance between impeller (4) and volute casing (1) is adjustable and the following procedure should be adopted.

The stationary seal seat should be fitted into the backplate and the seal clamp plate (9) tightened up carefully and evenly tightening the six nuts (13). It is important to ensure that the sealing ring (15) and the PTFE ring (16) are in position. The impeller stalk is now entered through the backplate (6) and the stationary seat (8). The rotating seal component is now fitted over the impeller stalk and at this stage, **not** pushed fully home. The complete backplate, impeller and seal assembly is now fitted to the motor shaft and mounting bracket (10). Ensure that the drive key is correctly fitted and replace the impeller retaining set screw (12) but do not tighten at this stage. Fit the pump volute casing (1) to the backplate (6) **without** joint ring (7) and clamp up with only two diametrically opposite clamp bolts (14). The impeller should now be pushed forward against the pump casing (1) and the impeller retaining set screw (12) fully tightened. The pump casing is now removed and the joint ring (7) fitted onto the backplate (6). The pump casing may now be refitted and all eight clamp bolts tightened evenly. The suction and discharge pipework may now be reconnected to the pump.

SEAL ADJUSTMENT (TYPE 10T)

1.6 The axial setting of the rotating component of the seal should be carried out in accordance with the manufacturers leaflet enclosed with these instructions.

NOTE

After re-build, check that the pump is fully primed with liquor before starting the electric motor, or seal damage will occur. The pump must not be run dry, otherwise serious damage to the seal faces will be inevitable.

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MAINTENANCE OF THE MHC PUMP

PLEASE READ CAREFULLY BEFORE OPERATION

GENERAL

1.1 Normal running maintenance of this pump is restricted to the motor bearing lubrication. However, leakage of the mechanical shaft seal and/or wear of the parts in contact with the liquor will necessitate maintenance or replacement of parts. Wear is usually indicated by a gradual falling of the pumps performance. The running time for this to occur will depend upon the corrosive or abrasive nature of the liquor being pumped. Item numbers used in the following sections refer to those from the sectional arrangement drawing L 15609.

DISMANTLING (CRANE TYPE 1A MECHANICAL SEAL) DRG NO. L 15609

1.2 If the motor (1) and mounting bracket (10) are to be left in situ, then sufficient length of suction piping must be removed to enable the volute casing (8) to clear the impeller (6). This length varies with the size of the pump, but 0.2m will generally be sufficient in all cases. Otherwise break the suction and discharge joints, disconnect the electrical connections and remove the pump and motor complete. Disconnect the seal flushing pipe (15) if fitted. Slacken off the clamp bolts (14) evenly and remove. Remove the clamp plate (9). Break the joint between volute casing (8) and backplate (5). The volute casing (8) can now be removed exposing the impeller (6). Remove the joint ring (12) and the impeller retaining grubscrew (13) completely. The impeller (6) can now be drawn off the motor shaft complete with the rotating seal assembly. Ensure that the separate rotating seat is removed with the seal assembly. Remove the backplate (5) complete with the stationary seat of the mechanical seal. This seat is a press fit in the backplate (5) and if replacement is necessary, it should be pressed home evenly. In the case of ceramic seats a suitable mandrel **must** be used. Before pressing home lubricate, the rubber sealing ring with silicone grease or similar to assist fitment.

RE-ASSEMBLY (CRANE TYPE 1A MECHANICAL SEAL) DRG NO. L 15609

1.3 In general re-assemble in reverse order to the previous section. The diametral clearances are fixed by the spigot location of the pump components and no adjustment is necessary or provided. However, the axial clearance between the impeller (6) and volute casing (8) is adjustable and the following procedure should be adopted. Fit the backplate (5) to the mounting bracket (10). Position the rotating seal assembly on the impeller. Position the motor shaft key so that the keyway is uppermost and then fit the shaft key. Making sure that the separate rotating face of the rotating seal assembly is not misplaced apply impeller to the motor shaft and press fully home against the mechanical seal spring pressure so that the impeller (6) contacts the pump backplate (5).

Holding the impeller in this position place the impeller retaining grub screw and temporarily nip-up. Fit the pump casing (8) to the backplate **without** joint ring (12) and clamp up with only two diametrically opposite pump clamp bolts. Slacken the impeller retaining grubscrew so that the impeller (6) springs forward against the pump volute casing (8). Finally tighten the impeller retaining grubscrew (13). Remove the pump casing (8) and fit the body joint ring (12) to the backplate. Fit the pump volute casing (8) eight body clamp bolts (14) and tighten evenly. Re-connect the suction and discharge pipework and electrical supply. Ensure that the correct direction is obtained, rotation is clockwise looking on the motor end.

NOTE

After a re-build, check that the pump is fully primed with liquor before starting the electric motor or seal damage will occur. The pump must not be run dry, otherwise serious damage to the seal faces will be inevitable.

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GENERAL POINTS REGARDING MECHANICAL SEALS

The main consideration in starting up equipment with mechanical shaft seals is to ensure that the seal faces are immersed in liquid from the very beginning so that they will not be scored or damaged by dry operation. The recommendations below will be applicable to most types of seal installations, if followed successful start-up and normal seal life can be expected.

(1) Caution that the equipment is not run dry while checking the electric motor for the correct direction of rotation. Kestner horizontal pumps are generally dispatched from the works with the spacer coupling disconnected to ensure that this does not occur. The direction should be checked and then the coupling can be connected for operation. A slight turnover by hand will not damage the seals, however, full motor speed for a short period under dry conditions will destroy or severely damage the rubbing faces.

(2) Sealant connections at the stuffing box should be connected and the specified coolant flowrate and pressure should be checked and confirmed prior to starting the equipment. Flow switches in the sealant supply lines may be beneficial to prevent energizing the electric motor drive under 'no-flow' conditions.

(3) On hot operational equipment that is shut down at the end of the day, it is generally advisable to leave the sealant liquid flowing at least long enough for the seal chamber to cool below the temperature limits of the materials in the seal.

(4) Most double mechanical seals are dependant upon the controlled pressure and flow of the sealing fluid to function correctly (generally a minimum of 1 bar above the stuffing box / discharge pressure). Even before the shaft is rotated the sealing liquid pressure must exceed the product pressure opposing the seal.

(5) A squealing noise indicates insufficient liquid at the seal faces (that is the faces are running dry) and to avoid reduced seal life the installation should be checked immediately. Dry operation from the sudden loss of suction liquor is sometimes encountered and should be rectified immediately to prevent possible damage to the seal faces.

(6) New plant start-up should consider the presence of dirt and debris in the system during construction. This cannot be eliminated entirely however, proper cleaning and flushing pipelines prior to running the equipment can greatly eliminate many seal failures. The use of strainers, cyclone separators and filters on critical installations during commissioning is often advisable for new plant initial start-up as a large percentage of seal failures occur during the commissioning process.

(7) If a seal leaks slightly on start-up allow a reasonable period of time for it to adjust itself. Liquids with good lubricating properties will naturally take longer to bed-in. When a seal starts out with a slight leak and gets progressively less with running, it is indicative of a leakage across the seal faces and continued running will cure it.

Where leakage occurs initially and is not affected by running it generally indicates seal damage or misalignment.

(8) Unless absolutely necessary **DO NOT OPEN SEAL FACES FOR INSPECTION**. After a seal has been running for some time a wear pattern is established between the two faces which microscopically mates these two faces, since it is very unlikely that the two faces can be put back together in their exact wear pattern position, disturbing the seal in any manner will probably necessitate establishing a new wear pattern, perhaps after re-lapping the mating faces.

(9) **CAVITATION**:- Excessive cavitation can cause seal failure, in addition to any damage which may occur in the pump. Cavitation causes severe vibration of the pump shaft, shaft deflection and bearing failure. Pump cavitation is generally indicated by excessive noise in the pump casing.

(10) Stand-by equipment having mechanical seals should not be allowed to stand idle for long periods of time. Rotate the equipment at least once a week, if only for a few moments. Better still allow a designated period for placing the unit on line. This procedure will generally only take a minimum period of time and effort as almost all stand-by and duty equipment have common suction and delivery pipework.

(11) It should be borne in mind that the driver alignment is checked at our works prior to dispatch, however, this should be re-checked after final installation at site. Also the effect of pipework strain is well documented as to the damage it can cause to pump bearings and seals. Pipework should be of the correct size, properly aligned and adequately supported with expansion bellows fitted if necessary. The pump suction and delivery branches should not be used as pipework supports.

(12) Long term storage: It is recommended that mechanical seals left in storage for over 2 years are returned to the manufacturer for inspection.

For seals already installed in the equipment :- Pumps subject to long term storage (over 1 year) are best stored without the mechanical seals being fitted. Seal installation should only then be carried out shortly before the actual start-up of the equipment.

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REMOVING THE COMPLETE SEAL

(A) Remove the seal unit from the equipment. Any adapter ring/abutment collar can be left on the shaft, located in its correct position. The seat and its sealing component(s) can also be removed. The seat is to be cleaned and de-greased before being coated in a film of oil and sealed in Polythene wrapping. All PFTE and Elastomer parts can be disassembled, dried and stored in black plastic bags before being kept in a cool, dark area. The seal unit is to be totally dried and stored in polythene wrapping or a bag containing a moisture absorbing agent, (eg a bag of silica gel). The rotating shaft and seat recess/abutment on the equipment should be thoroughly cleaned, de-greased and dried before being protected from corrosion for the duration of its time in storage.

(B) **Leaving the seals in the equipment**:-

Pumps equipped with double seals:- The seal chamber is to be filled with ethylene glycol with an inhibitor to prevent corrosion. Suction and discharge flanges are to be covered to exclude the ingress of dirt. Covers should be marked:- **DO NOT REMOVE UNTIL EQUIPMENT IS INSTALLED.** The open area between the glandplate and shaft or shaft sleeve, it to be protected from airborne dirt, (eg with masking tape or suitable glued in rubber gasket ring, that has a close clearance with the shaft / sleeve O.D). If at all possible, the shaft should be rotated slowly by hand in the direction of the normal equipment approx once every week.

Pumps equipped with single seals:- The seal chamber should be completely dry. The seal faces should ideally be assembled dry also. If hydrostatic or acceptance testing is to be done by the equipment manufacturer, then the seal area must be flushed clean and totally dried afterwards. Pumps on cryogenic duties should be drained from the lowest point and then blown through with dry, hot air or Nitrogen for at least 30 minutes. Suction and discharge flanges are to be covered to exclude the ingress of dirt. Covers should be marked:- **DO NOT REMOVE UNTIL EQUIPMENT IS INSTALLED.** The open area between the glandplate and shaft sleeve is to be masked to exclude dirt. All open ports in the gland, adapter plate and stuffing box are to be plugged and sealed. Clamp bolts can be loosened off approximately 3 turns of the thread to relax the spring loading. The corresponding gap left between the stuffing box face and the glandplate should be masked to exclude dirt. If the shaft has to be rotated by hand occasionally to comply with the bearing manufacturers recommendations, then the sealing faces should be coated with a light film of clean lubricating oil.

IF THE PUMP IS TO BE STORED IN SITU, THEN IT IS RECOMMENDED TO DISCONNECT ALL ELECTRICAL CONNECTIONS TO THE PUMP MOTOR OR AT LEAST EARTH THE PUMP CASING.

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ELECTRIC MOTOR OPERATIONAL PROBLEMS

FAULT	CAUSE	REMEDY
Motor overheated	Motor connected in Delta instead of Star as described on nameplate.	Correct the connection
	Mains voltage deviates from the rated motor Voltage by more than 6%. Too high a voltage is particularly detrimental for multiple motors since such motors have 'no load' current approximately equal to the full load current even when operating on normal voltage.	Make arrangements for correct mains voltage to be applied.
	Volume of cooling air inadequate, cooling air ducts clogged.	Clean around motor cooling fans and arrange for unimpeded access & discharge of cooling air.
	Cooling air is pre-heated.	Arrange for cool air supply.
	Overload at normal mains voltage. Current excessive. Speed too low.	Install larger motor (size to be determined by measuring power).
	Motor capability exceeded (SI to S8) e.g the motor becomes overheated due to excessive switching frequency, in such cases it is not sufficient simply to use a larger motor since in all probability the same conditions would still arise.	It is preferable under these circum-stances to consult a qualified electrical engineer to determine the correct size of motor req in order that the motor may be adapted to suit the actual mode of operation.
	Supply cable has loose contact i.e (temporary single phasing) Burnt out fuse.	Correctly secure the loose contact. Replace the fuse.
Motor will not start	Fuse burnt out.	Replace the fuse.
	Motor protection switch has tripped.	Check motor protection switch for the correct setting and adjust.
	Motor protection switch inoperative fault in the control line.	Check operational & regulation of motor protection switch and rectify.
Motor will not start or starts with difficulty	Designed for delta connection but connected in Star.	Connect motor correctly.
	Voltage or frequency of electrical supply Deviates considerably from required value During starting conditions.	Improve mains supply conditions.
Motor will not start when connected in star will only start when connected in delta.	Torque insufficient from star connection.	If delta starting current is not excessive then re-connect for DOL starting, otherwise larger size of motor or motor Having special windings will be required.

FAULT	CAUSE	REMEDY
Motor hums and takes excessive current.	Fault in windings.	Motor to be examined and repaired by qualified electrical engineers.
	Rotor grazing.	Motor to be examined and repaired by qualified electrical engineers.
Fuses blow or motor protection switch trips immediately.	Short circuit on line.	Remove short circuit.
	Short circuit in motor.	Fault to be remedied by qualified electrical engineer.
	Line terminals incorrectly connected.	Correct the connections.
Wrong direction of rotation.	Motor incorrectly connected.	Interchange any two of the incoming main lines.

FOR WINDING FAULTS THE MOTOR MUST BE CHECKED AND REPAIRED BY QUALIFIED ELECTRICAL ENGINEERS.

One Phase burnt out.	One phase missing in delta connection motor protection inadequate.	Motor should be re-wound. Motor protective switch to be correctly set.
Two Phases burnt out.	One phase missing in star connection motor protection inadequate.	Motor to be rewound and protective switch adjusted correctly.
Three phases burnt out uniformly.	Overload, blocking, Excessive switching Frequency. Insufficient motor protection incorrect connection.	Motor to be rewound and protective switch adjusted correctly. Wiring to be Corrected and drive checked.
Winding fault (several windings burnt out in one slot).	Mechanical damage to winding or other insulation faults.	Motor to be rewound.

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BEARING DAMAGE AND CORRECTIVE MEASURES

DAMAGE	DESCRIPTION	CAUSES	CORRECTION
Flaking	The surface of the guide way begins wearing away. Conspicuous hills and valleys form soon afterward.	Excessive loads or improper handling improper mounting. Improper precision in the shaft or housing. Insufficient clearance. Contamination. Rust. Drop in hardness due to abnormally high Temperatures.	Review application conditions. Select a different type of bearing. Re-evaluate the clearance. Improve the precision of the shaft and housing. Re-evaluate the layout (design) of the area around the housing. Review assembly procedures and review lubricant type and lubrication methods.
Seizure	The bearing heats up and becomes discoloured. Eventually the bearing will seize up.	Insufficient clearance (including clearances made smaller by local deformation). Insufficient lubrication or improper lubricant. Excessive loads. (excessive pressure). Skewed rollers.	Check for proper clearance (increase clearances). Review lubricant type and quantity. Review application conditions. Take steps to prevent mis-alignment. Re-evaluate the design of the area around bearing (including the fitting of the bearing). Improve assembly procedures.
Cracking & notching.	Localised flaking occurs. Little cracks Or notches appear.	Excessive shock loads. Excessive interference. Large flaking. Friction cracking. Inadequate abutment or chamfer. Improper handling (gouges from large to Foreign objects).	Review application conditions. Select proper interference and review. materials. Improve assembly procedures & take care in handling. Take measures to prevent friction Cracking (review lubricant type). Re-evaluate the design of the area around the bearing.
Retainer damage	Rivets break or become loose Resulting in retainer damage.	Excessive moment loading. High speed or excessive speed fluctuations.	Review the application conditions. Review of application conditions.

		Inadequate lubrication. Impact with foreign objects. Excessive vibration. Improper mounting (misalignment). Abnormal temperature rise. (plastic retainers).	Re-evaluation of lubrication conditions. Review of retainer type selection. Take more care in handling.
Smearing & scuffing	The surface becomes rough & some Deposits form. Scuffing generally Refers to roughness on the race collar And the ends of the rollers.	Inadequate lubrication. Entrapped foreign particles. Roller skewing due to misaligned Bearing. Bare spots in the collar oil Film due to large axial loading. Surface roughness. Excessive slippage of rolling elements.	Re-evaluation of the lubricant type and lubrication method. Review of operating conditions. Setting of a suitable pre-load. Improve sealing performance. Take care to handle the bearing Properly.
Rust & corrosion	The surface becomes either partially or fully rusted, and occasionally rust even occurs along along the rolling element pitch lines.	Poor storage conditions. Poor packaging. insufficient rust inhibitor. Penetration by water, acid, etc Handling with bare hands.	Takes measures to prevent rusting while in storage. Improve sealing Performance. Periodically, inspect the lubricating oil. Take care when handling the bearing.
Fretting	There are two types of fretting:- In one, a rusty wear powder forms on The mating surfaces. In the other, brinelling indentations form on the raceway at the rolling element pitch.	Insufficient interference. Small bearing oscillation angle. Insufficient lubrication. Fluctuating loads. Vibration during transport.	Review the interference and apply a Coat of lubricant. Pack the inner & outer ring separately for transport. When the two cannot be separated Apply a pre-load. Select a different Type of lubricant. Select a different type of bearing.
Wear	The surfaces wear & dimensional deformation results. Wear is often accompanied by roughness and Scratches.	Entrapment of foreign particles in the lubricant. Inadequate lubrication. Skewed rollers.	Review lubricant type & lubrication Methods. Improve sealing performance. Take steps to prevent misalignment.
Electrolytic corrosion	Pits form in the raceway. The pits gradually grow into ripples.	Electric current flowing through the rollers.	Create a by-pass circuit for the current. Insulate the bearing so the current does not pass through.

Dents and scratches	Scoring during assembly, gouges due to Hard foreign objects and surface Denting due to mechanical shock.	Entrapment of foreign objects. Bite-in on the flaked off side. Dropping or other mechanical shocks Due to careless handling. Assembled misalignment.	Improve handling & assembly methods. Take measures to prevent the entrapment of foreign objects. Should the damage have been caused by little pieces of metal, thoroughly Check all other locations.
Slipping or creeping	Slipping is accomplished by Mirror-like or discoloured surfaces on The ID and OD. Scuffing may also occur.	Insufficient interference in the mating section. Sleeve not fastened down properly. Abnormal temperature rise. Excessive loads.	Re-evaluate the interference. Re-evaluate usage conditions. Review the precision of the shaft and housing.

NOTE While it is course impossible to directly observe bearings in operation, one can get a good idea of how they are operating by monitoring noise, vibration temperature and lubricant condition. Types of damage typically encountered are given in the above table.

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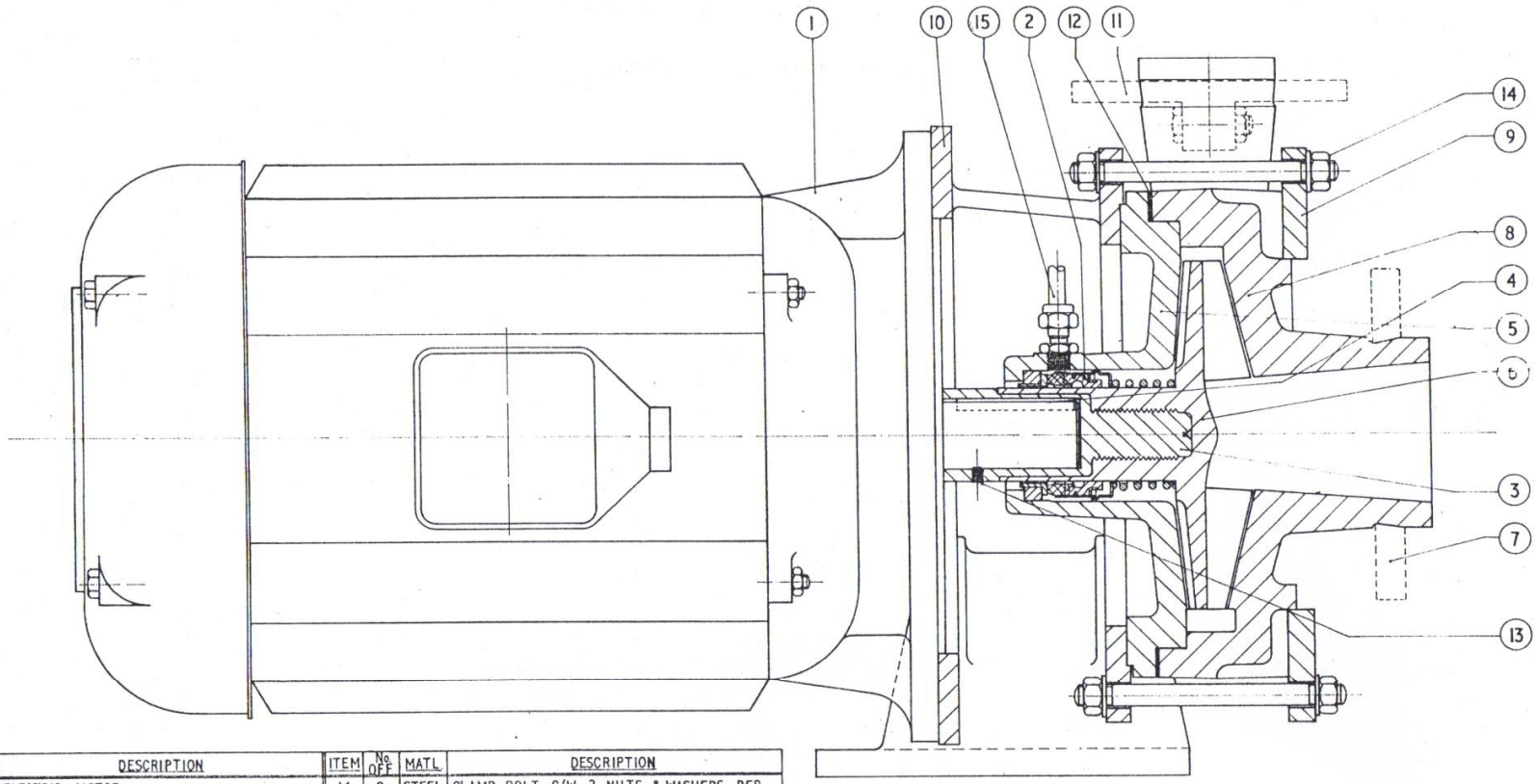

ITEM	No. OFF	MATL.	DESCRIPTION	ITEM	No. OFF	MATL.	DESCRIPTION
1	1		ELECTRIC MOTOR	14	8	STEEL	CLAMP BOLT C/W 2 NUTS & WASHERS PER
2	1		CRANE TYPE 1A MECH SEAL				BOLT
3	1	STEEL	ROTOR CENTRE	15			SEAL FLUSHING CONNECTION
4	1	STEEL	KEY				
5	1	K.B.	BACKPLATE				
6	1	K.B.	ROTOR				
7	1	C.I.	SPLIT FLANGE (SUCTION)				
8	1	K.B.	VOLUTE CASING				
9	1	C.I.	CLAMP RING				
10	1	C.I.	MOUNTING BRACKET				
11	1	C.I.	SPLIT FLANGE (DELIVERY)				
12	1	RUBBER	JOINT RING				
13	1	STEEL	SET SCREW				

TYPE MHC CENTRIFUGAL PUMP.