三六牌®

PC

石油化工流程泵
说明书

Petrol Chemical Process Pump
Instruction Book

大耐泵业有限公司

Danai Pumps Co., Ltd.

目录

Contents

大耐泵业有限公司

PC型石油化工流程泵
使用说明

三六牌®

■ 概　述

本使用说明书是对安装、使用和维修的重要论述。因此，对于装配人员以及所有的负责者在装配和开车前必须全部阅读本说明书，本说明书也适用于以后的安装、维修。

泵的使用安全仅在规定的使用场合(见数据单)下得到保证。

对于输送过热或过冷介质的泵，其泵的有关零件必须采取防止接触的措施，以免发生危险。

如果泵在停车后会产生回流，则必须在泵出口处安装一个防止回流的装置。

泵开车前必须安装好预防接触的装置(如联轴器防护罩)。

■ 型号标识

PC 50–1 200– 25x

PC–系列名称

50–泵的出口口径

1–轴承架号

200–叶轮的名义直径（mm）

25–泵的承压能力（bar）

X–泵的结构拓展，如下表示：

Q–开式叶轮；

E–副叶轮密封；

G–保温套设计；

■ 泵的说明

PC型泵属单级卧式离心泵。泵体分为脚支撑和中心支撑。该系列泵适用于输送各种腐蚀性的液体，其温度范围为−80℃～+450℃，最高使用压力可达7.5MPa。PC型泵执行AP1610和VDMA24297标准，可保证流程工业要求的维修条件，轴承、轴封和叶轮为一转子组件可进行迅速的拆卸或装配，大大缩短了停车维修周期。

叶轮为单吸径向闭式，带有叶轮耐磨环和泵体耐磨环，磨损后只需更换耐磨环，可降低维修和备件成本。

必须经常检查泵体、耐磨环和叶轮的腐蚀、磨损情况，并保证及时更换已腐蚀或已磨损的零件。

装配和拆卸时注意安全，防止零件脱落，保证泵的可靠性。

连接法兰、连接螺孔以及其它敞开部位在运输和存放期间必须保持封闭。

注意：对于泵单机或整机的吊运不允许使用泵部分或电机上的起吊环，起吊环仅供给装配或拆卸松开的单件吊运。泵单机 的吊运应将绳索绕在泵体法兰或轴承支架上，整机吊运应使用底座地脚螺栓孔。

泵盖上带有冷却或加热轴封箱体的结构。轴封有填料密封和机械密封两种类型，用户可根据不同使用工况选择。

轴承用润滑油润滑，轴承支架上带有恒位油杯，轴承支架分无冷却、水冷却和风扇冷却结构。

泵与电机间使用弹性联轴器作为连接元件，该元件可补偿小的轴向、径向和角度位移。

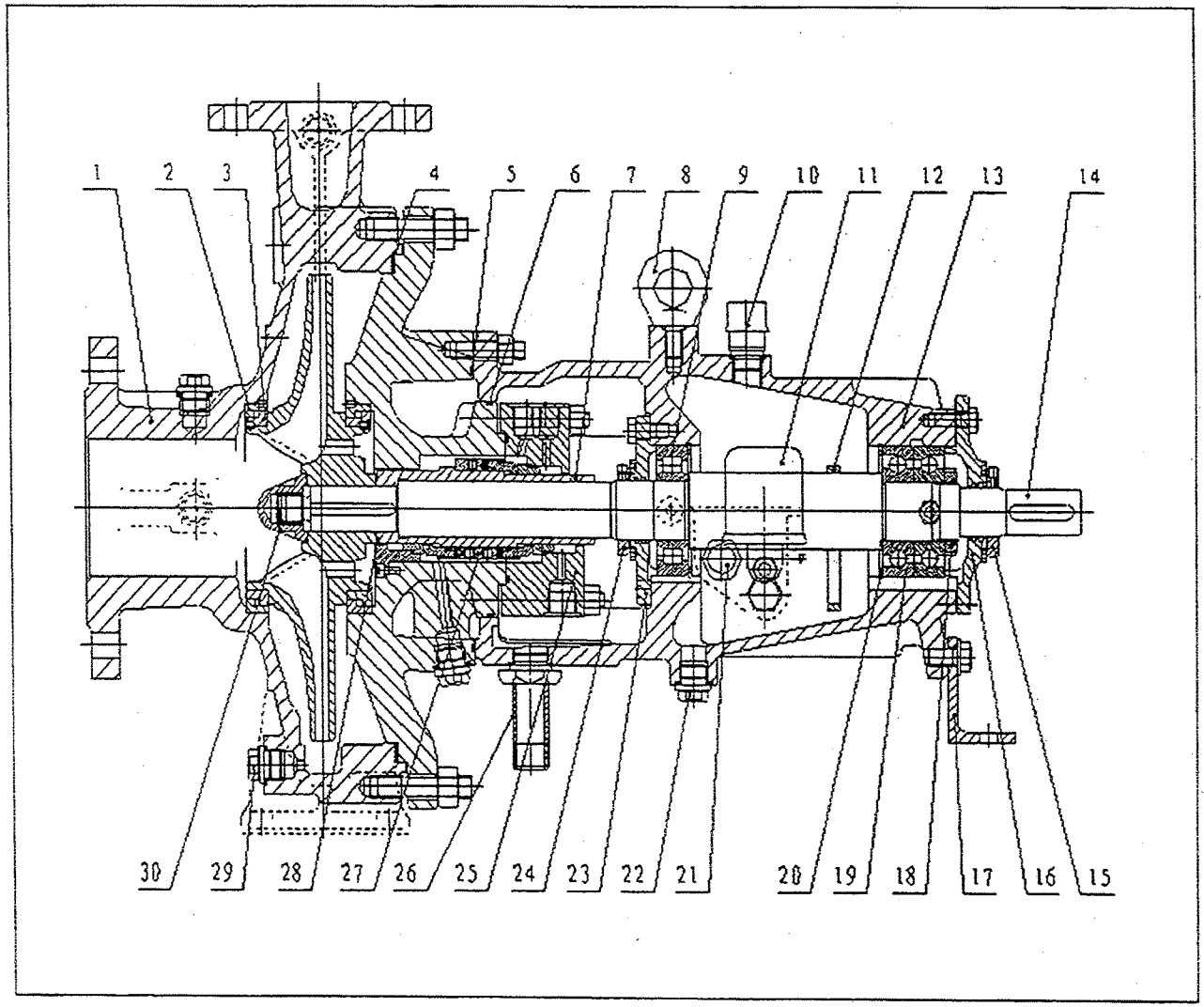


图2—2

1 泵体
※2 体口环
※3 叶轮口环
※4 平垫片
※5 O型圈
※6 O型圈
※7 轴套
8 吊环螺栓
9 轴承
10 油分离器
11 恒位油杯
12 甩油环
13 轴承支架
14 轴
※15 防尘盘
16 轴承压盖
17 支脚
18 圆螺母
19 轴承
20 挡圈
21 视油窗
22 螺塞
23 轴承压盖
※24 防尘盘
25 密封压盖
26 排液管
27 机械密封
※28 平垫片
29 螺塞
※30 叶轮螺母

泵的安装

4.1 泵的安装校正

4.1.1 泵主要的尺寸、连接件和地脚螺栓的位置等均能从样本中的泵外形尺寸图查到。

4.1.2 在安装和维修时必须具备合适的起吊设备，泵应能从所有地方靠近，并要备有手提灯，以保持充足的光线。

4.1.3 选择合理的安装位置和型式，保证泵运转平稳，不发生振动，以延长泵的使用寿命。

4.1.4 对于轴封、泵体出口、冷却系统等的泄漏必须提供一个无压排漏条件。

4.1.5 为防止污物进入泵内部，安装前必须遮盖好泵连接法兰和连接螺孔。

4.1.6 底座或其他基础必须进行修整、找准和清洗。对装配前所有准备工作必须全部完成，对大的组件必须提供传送到装配位置上的合适空间和通道。

4.1.7 泵和电机的安装

4.1.7.1 把带有泵和电机的底座放在基础上，并使地脚螺栓插入底座连接孔中。用不同厚度的调整垫片把泵调至水平位置。如对于长1600mm的底座，需要调整位置三处：一处是泵端较窄侧，另两处分别在电机端上左右两侧，用机械水平仪在水平法兰处沿泵轴线方向检查安装，并要使横向支管上的法兰垂直，见图3.1—1。允许最大偏差为0.1mm/m。

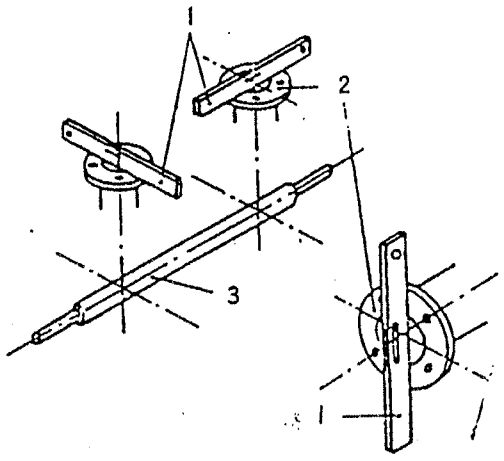


图4.1—1

1.水平仪
2.泵法兰
3.轴

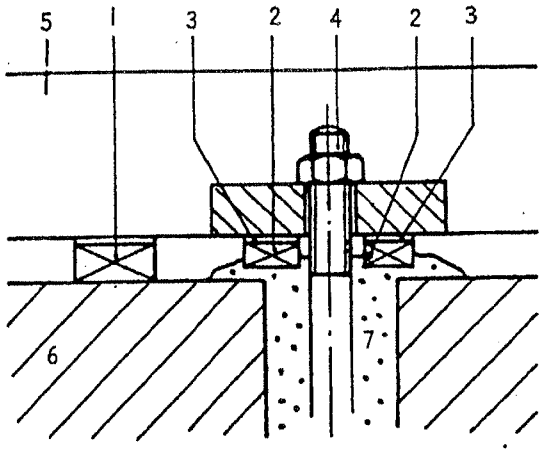


图4.1—2

1.调整垫
2.垫块
3.薄垫片
4.地脚螺栓
5.底座
6.基础
7.混凝土

4.1.7.2 浇筑混凝土于地脚螺栓孔时必须堆集到孔口上面一点，并调整混凝土堆上左右两侧的钢垫块，使底座和垫块间保持一个间隙，然后再用一或二片不同厚度的薄垫片填充(见图4.1—1)。

4.1.7.3 混凝土凝固后拧紧地脚螺栓，再检查水平安装，如果泵位置有变动，则重新校正。

4.1.7.4 校正后，用混凝土给底座灌浆(混凝土不要溢出)。凝固后，能影响到联轴器的校正，这将在4.2中描述。

4.2 联轴器校正

4.2.1 校正联轴器之前，根据泵上的转向箭头方向确定电机的旋转方向。

4.2.2 弹性联轴器调整，依靠放在电机下的调整垫片来对轴心线进行细心的校正，校正期间若粗心大意，将导致联轴器的损坏，以及泵和电机轴承的损坏。

4.2.3 安装和校正联轴器时必须详见安装图和说明书。

4.2.4 对于无中间段的联轴器校正，可用一根精密的直尺靠在联轴器外缘任意几点的纬线上观察与轴的平行程度，并用厚塞规在几个对应位置上控制规定的两个半联轴器间距离(见图4.2—1)。

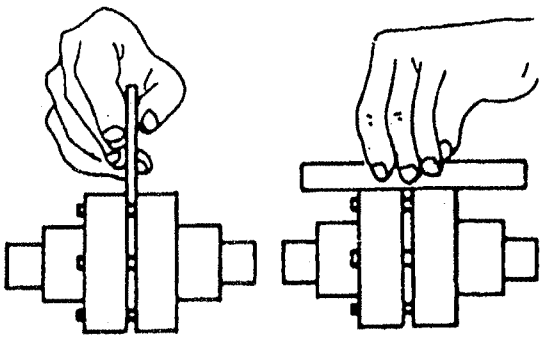


图4.2--1

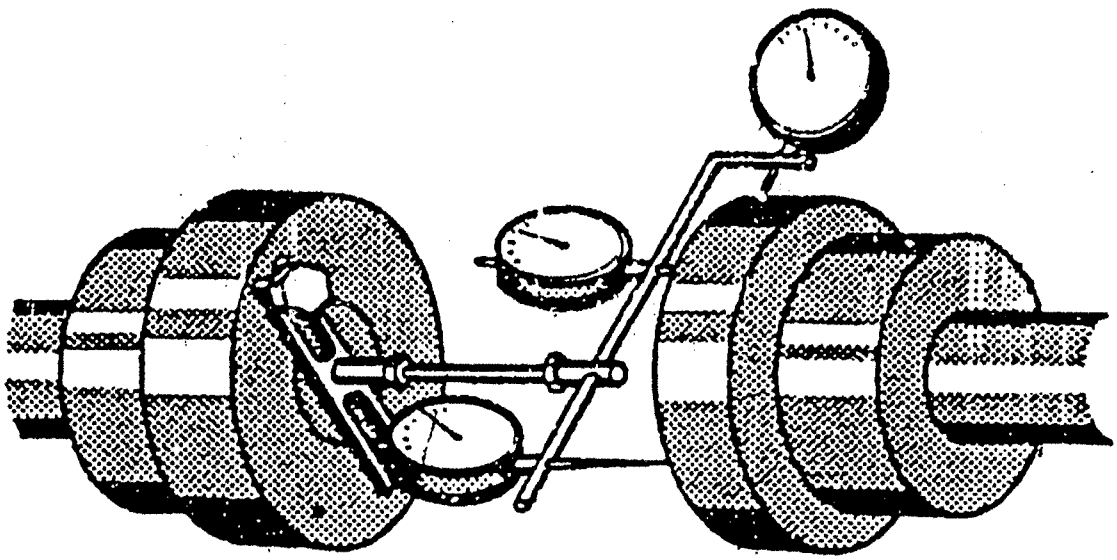


图4.2-2

4.2.5 如果要求更精确的校正(在转速＞3600rpm情况下或带有中间段情况下)，则必须沿径向和轴向用千分表来校正(见图4.2—2)。最大直径处轴向允差为0.05mm，尽量达到≤0.03mm；最大直径处径向允差为0.1mm，尽量达到≤0.05mm。

4.2.6 在较高使用温度情况下(大约130℃)，必须在热运转条件下进行精密校正。如果超出在4.2.5条中叙述的允差，则要找出原因，并排除。在多数情况下，由邻近管路的膨胀产生的高负荷和力矩不允许施加在泵法兰上，详见4.1.2.1条。

■ 管路及其辅助设备

5.1 吸入和排出管路

5.1.1 概述

装置的吸入和排出管直径通常是根据吸入管路中液体流速约为2m/S，排出管路中液体流速为3m/S，来计算，这在工艺设计中已确定(通常装置的排出管标准直径大于泵吸入管的标准直径)。因此，这里只给出安装管路时必须考虑的一些实际问题。

5.1.2 安装

5.1.2.1 采用支撑管路。这样就不致使泵进出口管由于管路重量和热应力引起力和力矩而产生的过分变形。管路连接法兰必须平行于泵法兰。

5.1.2.2 安装水平管路时，进液端管径应逐渐向端部增大，出液端(与泵相接端)管径应逐渐向端部减小，这样可避免产生气囊。

5.1.2.3 设计有利于流动的进出口管。当由小管径变到大管径时，要逐渐过渡，其规则为：圆锥过渡段的长度等于标准直径差的5～7倍。

5.1.2.4 对于法兰连接，不允许法兰间的密封垫遮住管路通道。

5.1.2.5 尤其要注意吸入和排出管路中的不规则过渡管段和短弯头，因为这些部位上将增大管路阻力，应尽量避免使用。对泵吸入口处，大的管路阻力将使入口压力降低，若压力太低将导致叶轮入口处产生汽蚀 。

5.1.2.6 在安装几台泵情况下，除平行连接的备用泵外，必须提供每台泵单独的吸入管路。备用泵与相对应的泵可有共同的吸入管路，这是因为在使用中始终只用一台泵。

5.1.3 管路清洗

5.1.3.1 开车前，必须认真清洗管路系统中的所有污物和杂质。对于焊接部件必须清除焊接部件的金属突出物。

5.1.4 静水压试验

5.1.4.1 应检查管路是否密封，然后按规范要求进行静水压试验。

5.1.5 管接头

管接头的标准通径必须与管路标准通径一样。如果泵进出口管的标准通径小于管接头的标准通径，则必须在两者之间安装圆锥过渡段。供给管路中的截止阀不允许直接与泵连接，以免使液体的紊流现象影响泵的吸入腔。为避免气囊，安装截止阀时，其手轮轴必须向侧面或向下。

5.2 辅助设备(压力、温度等测量仪器)应适用于泵的控制和维护保养(冷却、加热、冲洗和密封等)。所需的辅助设备应根据泵型号和使用条件来确定。

如果所提供的泵及辅助设备适用，则在使用现场安装辅助设备前应考虑下列情况：

——压力表应安装在支架上，并通过Φ8的测量管连接到泵进出口管或邻近管路的测量点上。为保证能中止压力表和排泄，在压力表的前面必须安装一阀门。

——温度计必须直接插入测量点，在液体敏感部位的插入深入≥40mm。在压力大于1.6MPa情况下，必须使用带防护管的温度计。

——泵的排液能通过长管排泄到底座收液槽中，或排泄到泄漏液收集管路中。在泄漏液管路中必须安装一个至少与泵体标准压力相等的截止阀。

——机械密封的泄漏液也能通过长管排泄到底座收液槽中，或排泄到泄漏收集管路中。

——需要带冷却系统的泵，在冷却腔体的最低位置布置冷却水给水管路，最高位置布置冷却水排水管路。在给水管路中必须安装一个调节阀，在闭式系统的排水管路中安装一个流量指示器，在开式系统中，排水管路必须通过排水漏斗来引导。

——需要带加热系统的泵，在加热管路中给水管路必须安置在最高位置，并在给水管路

中安装一个调节阀。排泄则通过收液管路。机械密封辅助系统必须根据图纸中给定的系统执行。如果管线是导向热交换器、压力传感器或密封槽的，则在管线最高点处应提供一个排气孔。在温差循环情况下，其管路直径最小必须为3/4″，最好为1″。流动线路必须从连续上升的方式布置，并且不允许有明显的弯曲。

——根据机械密封结构，如果要求冷却或冲洗是次要的，则必须安装急冷装置。

——最小流量控制，在输送液的流量位于规定的最小流量点以下时，液体将发生中间过热直到汽化，此时叶轮和口环处将严重损坏，导致泵的卡死，同时也将导致机械密封的损坏。为避免这一现象发生，必须设置一最小流量装置来控制输送液始终保持在规定的最小流量之上。

——最小流量控制装置——恒量旁通管。在泵出口法兰和排出管路中的截止阀之间连接一通向供给箱的旁通管路，在管路中安装一个用来限制流量的节流阀或截止阀。

——最小流量控制装置不在泵制造厂的供货范围内，必须由用户自己提供。在开式系统中，开车前必须关闭最小流量控制装置中的截止阀。

■使　用

6.1 启动

6.1.1 首次启动之前。

6.1.1.1 用轻油(不用石油产品)冲洗轴承支架腔体，并擦净。然后填充润滑油至视油窗中部。

6.1.1.2 检查联轴器的校正。

6.1.1.3 检查轴封(6.2条)。

6.1.1.4 泵的灌注

在泵处于倒灌或带压(高于大气压)情况下：打开吸入管路中的截止阀，打开泵和机械密封排气阀；缓慢转动泵转子，当输送的液体不带汽泡流动时，关闭排气阀。

在泵处于吸上情况下：吸入管路必须安装底阀。打开吸入管路中的截止阀，打开泵和机械密封的排气阀；用输送液灌注泵；缓慢转动泵转子；当输送的液体不带汽泡流动时，关闭排气阀。

6.1.1.5 通过电机瞬时接通来检查旋转方向和运转是否正常。

6.1.1.6 如果一切正常，则打开最小流量控制装置中的截止阀，调整节流阀至规定的最小流量点，并锁紧。

6.1.2 泵的启动和运行

6.1.2.1 打开辅助设备管路中的阀门(冷却管路启动后再打开)。

6.1.2.2 关闭排出管路中的截止阀，启动电机，然后缓慢打开排出管路中的截止阀直到压差减小到数据表中规定的值。

警告：压差不可以低于设计点太多，也不能在系统中有压力波动。

注意：泵出口压力表值等于压差加上泵入口压力表值。

6.1.2.3 监视电流表上的读数，保证电流不能超出电机性能牌上规定的值。

6.2 停车

6.2.1 关闭排出管路中的截止阀。

6.2.2 停止电机，同时注意转子缓慢停下的实际情形。

6.2.3 如果泵在吸上情况下和没有防止启动的措施时，则必须关闭吸入管路中的截止阀。

6.2.4 关闭辅助设备管路中的阀门(泵冷却后再关闭冷却水阀门)。

6.2.5 在有冷凝现象、结冻现象或长期停止使用的情况下，必须排除泵体和冷却腔中的液体。

6.3 使用控制

6.3.1 使用点(设计点)的检查。

在首次启动期间要详细考察下列参数：

——测出转速。

——读出泵排出管压力表值，并减去吸入管压力表值。按下式计算后压力值必须符合在给定转速下泵名牌上规定的扬程。

$$H(m)=\frac{1020\cdot P(MPa)}{\rho\ (kg/m^3)}$$

$$P(MPa)=\frac{H(m)\cdot \rho\ (kg/m^3)}{1020}$$

式中：H—泵扬程。

P—压差。压差等于泵排出压力表值减去泵吸入压力表值。

r—输送的液体比重。

——压力不应低于上述值，否则将超出最大允许流量，甚至能间断流动。

■ 维护保养

7.1 泵

7.1.1 在使用期间中检查泵机组运转的平稳性和有无振动现象，注意异常的运转噪音。在未知的噪音和故障发生原因的情况下应立即停车，查明原因并排除。

7.1.2 定期检查联轴器的校正(至少一年一次)，排除变形，避免损坏。

7.1.3 如果有下列辅助设备，在使用期间应进行检查：

冷却：检查流量和温度。

加热：检查温度和压力。

密封的冲洗：检查压力、温度和流量。

7.1.4 设有备用泵情况下，为了保证能立即投入使用状态，应定时启动这些泵。在长期停车情况下，应排除输送的液体，如有冷却水也应排出。

7.1.5 如果泵性能不是因为管路系统的改变或水垢引起管路阻力的改变而产生降低，则泵性能的降低可能是泵内部零件的磨损所引起的。此时必须检修泵，更换已磨损零件(有关检修见第8节)。

7.1.6 关于泵的润滑和检修等全部使用情况和细节应详细记载，形成档案。

6.3.2 流量的确定

根据压力计算出扬程，然后在给定的泵性能曲线上确定出流量。具体方法见图6.3—1，在性能曲线上找出扬程的计算值，确定水平线与曲线H的交点，读出交点曲线下的流量值，此值就是所要确定的流量。

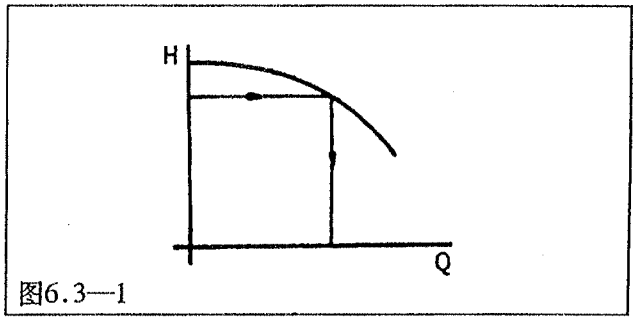


图6.3—1

7.2 填料密封

7.2.1 结构

根据输送液体和使用条件，填料在填料箱体中可以不同方式布置(所提供泵的布置见轴封剖面图)。

带有水封环的结构：

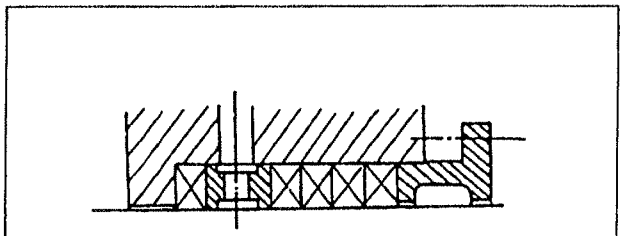


图7.2.1-1

配有密封液的水封环布置在填料腔中部。当轴封处的过压<0.02MPa并当液体润滑恶劣时，必须有密封液。密封液压力最小应大于轴封处压力0.1MPa。

带有填料压盖冷却的结构：

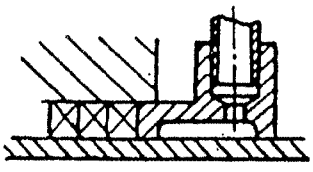


图7.2.1-2

为了避免由于轴封处压力的降低而使热液体(如110℃以上的水)产生蒸发，在填料压盖处必须冷却。冷却水量和压力必须由调节装置调节(0.02MPa时大约为0.05m³/h)。冷却水和泄漏液的混合液温度最高允许40℃。

7.2.2 使用状态

填料箱体的功能是把填料施加在液体上的压力(液体内部压力)传递到各个方向，因此填料必须充满填料腔和轴套间的空间(除小量径向间隙)，这样将大大地节制了静止部件和转动部件间的泄漏。为了获得良好的功能，必须保证其间润滑性和热传递。

7.2.3 填料

泵在出厂以前填料已装填好，如果发运到使用现场不能在12周内进行首次启动，则在试运转之前短期内必须取出原填料，更换新填料。

在装填料之前，清洗轴套和填料腔，检查轴套表面是否正常，并应检查轴套表面跳动，其允差如下：

轴封压力≤2.5MPa的跳动=0.05mm，表面粗糙度=$\sqrt{0.4}$；

轴封压力＞2.5MPa～5.0MPa的跳动=0.03mm，表面粗糙度=$\sqrt{0.4}$；

轴封压力＞5.0MPa～10.0MPa的跳动=0.02mm，表面粗糙度=$\sqrt{0.4}$；

为了再次填装，应具备充足的填料。用填料压盖将填料环依次压入填料腔时，填料环剖切截面彼此间要相互错开90°。

在未灌注的空泵上均匀地压紧填料压盖，不要歪斜，用检测仪器检查压盖法兰和填料腔间各侧的距离，使其保持均匀，然后松开填料压盖，拧上六角螺母。

7.2.4 监视

填料密封应限定其泄漏量，以保证良好的冷却、润滑和运转平稳性。对于泄漏液温度在60℃以下的情况下，其泄漏量应限定在1　/h(相当于每秒1滴)到15　/h(相当于稀液穿过的2mm的孔量)。

对于轴封压力≤1.0MPa的泵：

有较大泄漏量时，均匀地压紧填料压盖，不要倾斜，也不要太用力，如果重新压紧后泄漏量仍较大，并且泄漏液温度超过允许极限，则应重新更换填料环。

轴封压力＞1.0MPa的泵：

有较大泄漏量时，不允许再压紧填料压盖，否则将导致轴封的损坏。出现这种情况应重新更换填料环。

每次装填新填料后，都必须经过一段磨合期，在这期间必须时常注意检查，磨合期后泄漏量将有所减小。

7.2.5 填料材料

填料材料必须根据输送液体和使用参数选定。

一般情况下提供的填料材料为柔性石墨和碳素纤维，特殊订货注明其它材料，也是可以的。

7.3 单端面机械密封

为了保证具有良好的密封性能和平稳的运转，在两个密封环(动环和静环)间必须保持一液体薄膜，因此所输送的介质应满足下列条件：

——足够的润滑特性。

——汽化温度大于工作温度。

——在密封环区域的介质不含杂质和颗粒。

密封的辅助系统有：

——自冲洗。

——冷却。

——加热。

单端面机械密封的维护，主要包括对辅助系统、泄漏量和密封温度的监控。在正常循环冲洗情况下，冲洗液温度不得高于接近泵体处的温度。在冷却或加热情况下，其压力、流量和温度应按规定值执行。

注意：单端面机械密封的允许泄漏量为10cm³/h。当泄漏量较大(≥50cm³/h)时，可断定密封件已损坏，应立即检修。如果磨损的密封环(动环或静环)不可能再次抛光，则必须换新。在每次拆装密封时，静密封件(如O形圈)须更新。

7.4 双端面机械密封

轴封由两个(一个内和一个外)背靠背布置的机械密封组成。在两密封之间的空间里必须输入密封液，密封液的压力应高于靠近密封处输送介质的压力(最小高0.1～0.3MPa，最大高0.7～1.0MPa)，这样将有如下特点：

——由于增加接触压力，使得密封环接触面间有更好的密封性。

——密封环间有良好的润滑性。

——阻止输送介质外漏。

双端面机械密封辅助系统在使用过程中应完成下列任务：

——形成要求的过压。

——密封液循环。

——在使用期间填充密封液。

双端面机械密封的维护主要包括对密封液的及时填充，对密封和辅助系统温度的监控。进出口管路必须保证具有一定的温差。

注意：当密封液有较大损失时，可断定密封件已损坏，应立即检修。如果磨损的密封环(动环或静环)不可能再次抛光，则必须换新。在每次装拆密封时，静密封件(如O形圈)必须换新。

7.5 串联式机械密封

由两对密封环(动环或静环)串联布置而组成的机械密封。为了保证具有好的密封性能和平稳的运转，在两个密封环(动环和静环)间必须保持一层液体薄膜，因此所输送的介质应满足下列条件：

——足够的润滑性。

——汽化温度大于工作温度。

——在密封环区域内介质不含杂质和颗粒。

密封的辅助系统有：

——冲洗。

——冷却。

——加热。

——旋涡分离器或过滤器(在输送含杂质或颗粒的液体的情况下)。

串联式机械密封的维护主要包括对辅助系统、泄漏量和密封温度的监控。在正常循环冲洗情况下，冲洗液温度不得高于接近泵体处的温度。在冷却或加热情况下，其压力、流量和温度应按规定值执行。

注意：串联式机械密封的允许泄漏量为10cm³/h。当泄漏量较大(≥50cm³/h)时，可断定密封件已损坏，应立即检修。如果磨损的密封环(动环或静环)不可能再次抛光，则必须换新。在每次拆装密封时，静密封件(如O形窗)必须换新。

7.6 润滑

7.6.1 轴承润滑

7.6.1.1 轴承需要适量的润滑油来润滑，并且润滑油中不允许含有任何杂质和酸等。

7.6.1.2 轴承在运转过程中自身发热将对润滑油的黏度变化起非常重要作用，黏度将直接影响到润滑性能。为保证轴承具有良好的润滑条件，要求在轴承的使用温度范围内润滑油的运动黏度至少为12mm²/S，所以润滑油的黏度必须如下选取：

表3

轴承支架温度℃	运动黏度mm²/S	最低闪点℃
>50～75	V50=25	145
>75～85	V50=36	145

表4

轴承支架温度℃	换油周期(月)
>50～75	12
>75～85	6

7.6.1.3 在首次交付使用或者轴承检修后重新使用情况下，泵运转10～15小时后将所有的润滑油排除并清洗泵的运转部件，然后重新换润滑油，正常使用。正常使用期间应按下列周期定期更换润滑油。

7.6.1.4 定期检查轴承箱内润滑油或轴承腔的温度，允许范围如下：　　表5

检测点 / 范　围	位于轴承附近轴承箱表面处℃	轴承外圈处℃	轴承箱内油温℃
正常长期运转	≤80	≤90	≤70
应注意	80～≤90	90～≤100	70～≤80
机组应切断	90～≤100	100～≤110	80～≤90

7.6.2 恒位油杯的补油

7.6.2.1 通过轴承箱上的加油孔填充润滑油，直到恒位油杯的支管开始充上油为止。用同种润滑油填充恒位油杯，如图7.6.2—1示，再扣上恒位油杯。重复进行上述填充恒位油杯和扣上恒位油杯，直到润滑油充满恒位油杯2/3为止，如图7.6.2—2示。在使用中时常检查恒位油杯供油情况，发现油位下降要立即补充润滑油。若恒位油杯本身密封失效漏油，则要更换恒位油杯。

7.6.2.2 如果轴承箱体中的油位降低，则要通过供油箱及时加油，直到达到上述油位。

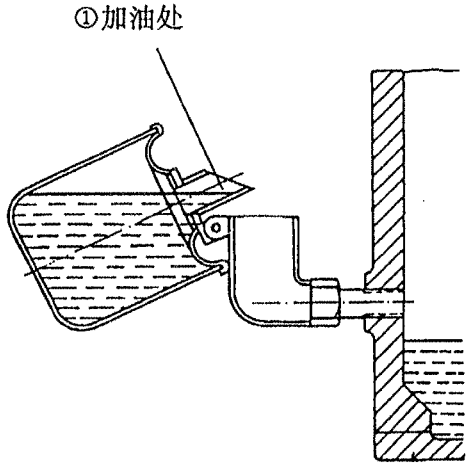


图7.7.2-1

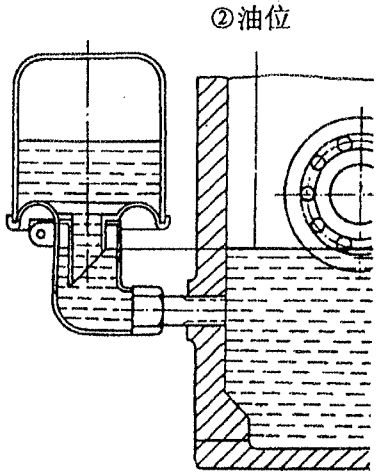


图7.7.2-2

■ 检 修

为避免拖长停车检修周期，应尽早采购好所必要的备品备件(如易磨损的零件)。当采购备件时，应向制造厂提供零件确切的种类(名称等)，泵型号和制造厂编号(见泵标牌)。

8.1 拆卸

8.1.1 准备工作

——关闭进、出口阀门，并保证在未经许可情况下，不得打开阀门。

——电机处于停止状态，并防止启动。

——排空泵中输送介质和润滑油。

——拆除联轴器防护罩和联轴器。

——拆除所有的仪器和辅助设备及管路。

8.1.2 可拆组件的拆卸

——松开底座上的脚支承螺栓。

——用拆卸工具拉出可拆组件(包括带轴和轴承部件、泵盖和叶轮)。大组件情况下，可用吊钩挂

8.1.3 轴封的拆卸

对于填料密封或机械密封：

——锁定泵轴，拧开叶轮螺母。

——抽出叶轮。

——松开轴封外部零件(机械密封压盖或填料压盖)。

——把泵盖从轴承支架上分离开，并抽出。再从泵盖上的轴封腔内拆除剩余的密封零件。

——在机械密封的情况下，把轴套和转动密封零件一起抽出。

8.1.4 泵轴的拆卸

——抽出轴套。

——抽出泵端半联轴器。

——轴承支架带有风冷却时，拆除风扇罩和风扇。

——拆除轴折流盘。

——拆除轴承前后压盖，并拆除联轴器端的轴承紧固件。

——用有防护橡胶罩的锤将轴从联轴器侧敲出轴。

——抽出轴承。

——对于轴承支架带有水冷却的情况下，则取出冷却水套，并清洗冷却腔。

8.2 内部零件的检查

检查所有的易磨损零件，如有损坏，则重新加工或换新。

8.2.1 叶轮和间隙

检查由于腐蚀和磨损而损坏的叶轮，如损坏严重则应换新。测定叶轮口环和泵体口环间的间隙，如超出限定范围，则必须换新，叶轮口环和泵体口环间允许的间隙如下表：

表6

叶轮口环间隙处直径	<75	75～140	140～200	200～320	320～400	400～600
径向间隙	0.3	1.2	0.5	0.6	0.7	0.8①
(新零件)	0.5	1.8	0.7	0.8	0.9	1.0②
最大径向间隙	0.9	0.4	1.5	1.8	2.0	2.5①
(用过零件)	1.5	0.6	2.0	2.5	2.8	3.0②

注：①铸铁或软氮化钢　②不锈钢

8.2.2 轴的校直

在轴两端中心孔处定位安装，并对轴进行校直试验（最大允许偏差0.025m）对于径向跳动为3倍允许值的轴通常不能再使用。

8.2.3 轴封部件

8.2.3.1机械密封

——密封环（动环或静环）表面不允许有任何划痕，如果有则要重新研磨，有深沟槽或裂纹情况下，应更换新密封环。

——检查轴套表面（尤其是在旋转组件的位置上）是否平整、光洁，如果有划痕等问题，则要重新磨削或换新轴套。

8.2.3.2 填料密封

检查轴套，如果其直径不大于计算直径减1mm，则可重新加工修复，并按新直径配填料环，在高压情况下（超过1.0MPa）则必须更新轴套。

检查填料压盖与轴套间的间隙，并按下表控制：

表7

轴封处压力		≤1.0MPa	>1.0MPa
填料压盖处直径间隙	正常	1	0.6
	最大	2	1.2

8.2.4 轴承

——用轻油清洗轴承，如有损坏则应换新轴承。

8.3 重新装配

8.3.1 准备工作

——清洗泵零件。

——选择合适的润滑油。

——对于开式叶轮的泵，用新的密封圈预先安装前、后耐磨板，对于水冷却的轴承支架，冷却腔应预先装好。

8.3.2 泵轴的装配

——在油槽中把轴承加热到80℃，然后套在轴上，并固定。

——把带有轴承的轴从联轴器侧插入轴承支架，并盖上轴承压盖；在此之前，应预先将耐油密封胶涂到轴承压盖密封面上。

——装折流盘，风冷却时应装风扇和风扇罩。

——压入泵端半联轴器，对于铸铁口径≤100mm和钢口径≤50mm的联轴器采用冷装，对于铸铁口径＞100mm和钢口径＞50mm的联轴器采用热装（在槽中重新加热到80℃）。

8.3.3 轴封的装配

8.3.3.1 机械密封

——把带有密封环（动环和静环）的组件插入密封压盖中，再放入辅助密封件，然后全部压到轴上。

——把泵盖装到轴承支架上，并拧紧，同时也插入机械密封，并拧紧。

8.3.3.2 填料密封

——把填料压盖和轴套套在轴上，如果有水封环，则同时套上。

——把泵盖放到轴承支架上并拧紧；装入填料环，压上填料压盖。

8.3.4 可拆组件的最终装配

——安装叶轮，并拧紧叶轮螺母，叶轮螺母靠内装的钢丝螺套来防止松动，经过5～10次拆装后，钢丝螺套的自动锁紧功能将减低，应换新的叶轮螺母。

——把密封平垫片放入泵体。

——装上可拆组件，并拧紧泵体双头螺柱和螺母。把紧底座上的脚支承螺柱。

8.3.5 最终装配

——连接辅助管路和仪器。

——把联轴器接到驱动器上，并校正，详见3.2条

——安装联轴器防护罩。

PC
PETROLEUM CHEMICAL PROCESS PUMP OPERATION INSTRUCTION

Brief Descr iption

This Operation Instruction is the important discussion on installation ,operation and repair ,therefore assembling persons and all persons in charge must read this Instruction completely before assembling and starting and this instruction is also suitable for installing and repairing later.

The operation safety of the pump is only ensured in the case of operation as specified(See data sheet).

As to the pump transporting too hot or too cool medium, for the relative parts of the pump, measure of prevention from contact must be taken to avoid occurrence of danger.

If after the pump has been shut down, it may produce reflux. then at the place of exit of the pump, a reflux prevention device must be installed.

Devices preventing from contact (such as coupler guard) must be installed before starting-up of pump.

The condition of corrosion and wear of the pump body, wearing ring and impeller must be often inspected and it has to ensure that the parts already corroded or already worn out will be replaced in time.

During assembling and dismantling, it has to pay at tention to safety to prevent the parts from coming off to ensure the dependability of the pump.

As to the connecting flange, connecting thread bore and other opening place, they must be remained closed during transporting and storing.

Attention: As to lifting transportation of pump single or entire machine, it is not allowed to use the eyebolt on the pump part or motor. The eyebolt is only for lifting transportation of single piece loosed during assembling and dismantling. As to lifting transportation of single machine of pump, it has to use rope to wind around the pump body flange or bearing support and as to lifting transportation of entire machine, it has to use the foundation bolt hole of the base.

Symbol

PC 50–1 200– 25x

PC–series

50–discharge branch(mm)

1–bearing bracket size

200–nominal impeller diamete(mm)

X–pump structure,as below:

25–pump max,pressure(bar)

O–opened impeller;

F–assistant impeller sealing;

G–heating coating design;

Descr iption of Pump

The PC type pumps belong to single stage horizontal centrifugal pump. The Pumps boby is supported by feet or at the center. Pumps of this series are suitable for use of transporting all kinds of corrosive liquid and their temperature limits are -80℃～+450℃ and the highest operating pressure of PC type pump attains 7.5MPa.

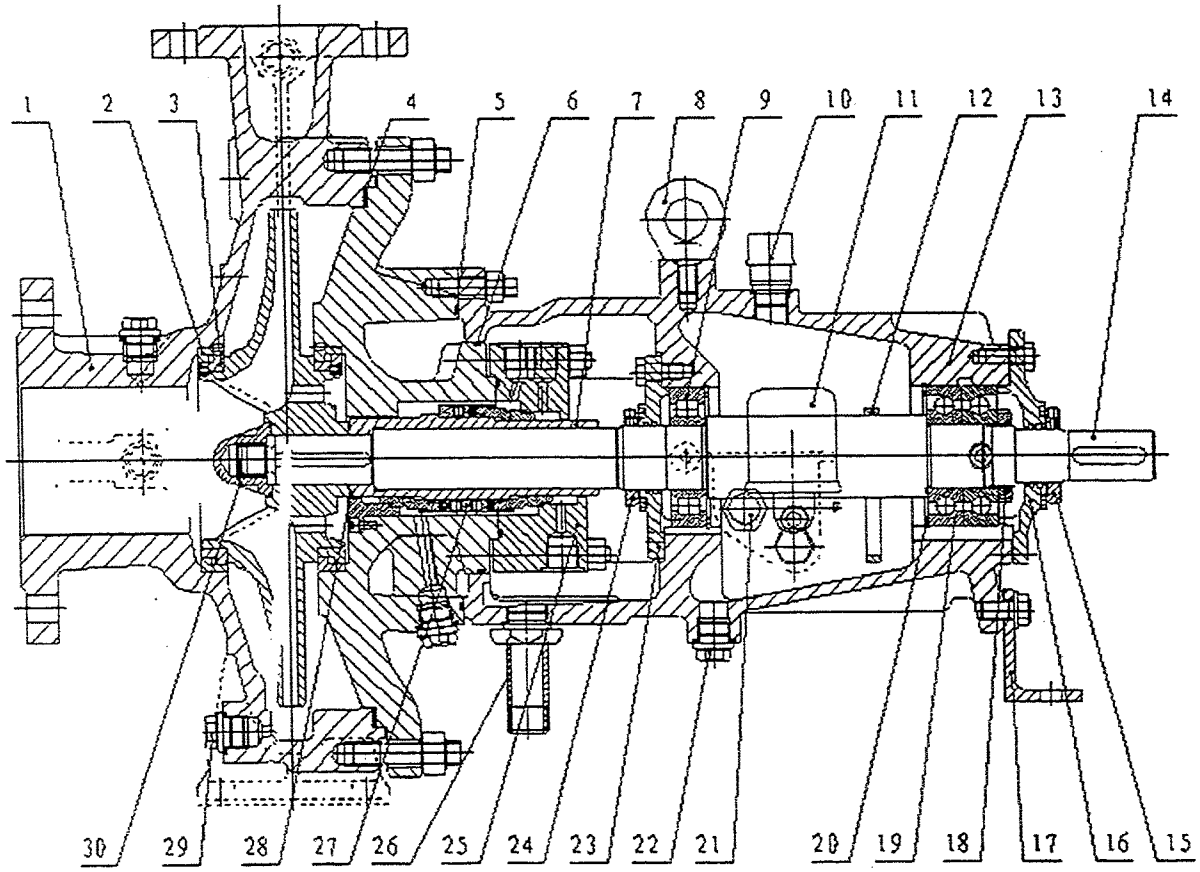
The pumps of PC types execute standards of API610 and VDMA24297 jointly ,which is able to ensure the condition of maintenance demanded by process industry and the bearing, shaft sealing and impeller are arotor unit which can be dismantled and rssembled rapidly, which is greatly shortening the period of stopping for repairing.

The impeller is of single suction radial closed type and carries with impeller wearing ring and pump body wearing ring and after being worn out , it needs only to replace wearing ring, which is able to decrease the cost of maintenance and spare parts .

On the pump cover, it is with the structure of cooling or heating shaft sealing case body. For the shaft sealing, there are two kinds, stuffing sealing and mechanical sealing, which can be selected by user according to the working condition of different operation.

The bearing is lubricated with lubricating oil and on the bearing support, it carries with permanent position oil cup. For the bearing support, it is divided into structures of without cooling, water cooling and fan cooling.

Between the pump and the motor, elastic coupler is used as connecting part, which part is able to compensate small axial, redial and angular displacements.



1 volute casing
※2 casing wear ring
※3 impeller wear ring
※4 flat gasket
※5 O ring
※6 O ring
※7 shaft sleeve
8 eye bolt
9 bearing
10 vent filter
11 constant level oiler
12 lubricating ring
13 bearing bracket
14 shaft
※15 deflector
16 bearing cover
17 supporting foot
18 bearing nut
19 bearing
20 circlip
21 oil level indicator
22 drain plug
23 bearing cover
※24 deflector
25 sealing cover
26 drain pipe
27 mechanical seal
※28 flat gasket
29 drain plug
※30 impeller nut

Installation of Pump

4.1 Rectification of Installation of Pump

4.1.1 As to the major dimension, connecting parts and position of foundation bolt etc. of the pump, they all can be found from the outward dimension diagram of the pump in the catalogue.

4.1.2 During installing and maintaining, suitable lifting equipment must be provided with, the pump should be able to be got near to from all places and it is also prepared with portable lamp to maintain sufficient light.

4.1.3 Select reasonable installation position and form to ensure the pump to run steadily without occurring of vibration to prolong the life of operation of the pump.

4.1.4 As to the leaking of shaft sealing, exit of pump body and cooling system etc., it must provide a condition of eliminating leakage without pressure.

4.1.5 In order to prevent dirts from entering into internal part of the pump, before installing, the connecting flanges and connecting thread holes of the pump must be well covered.

4.1.6 The base and other foundation must be repaired and maintained, making accuracy and cleaned. As to all the preparatory works before assembling, they must be completed and as to the big unit, it must be provided with suitable space and passage transferring to the assembling position.

4.1.7 Installation of Pump and Motor

4.1.7.1 Have the base carried with pump and motor placed on the foundation and have the foundation bolts plugged into the connecting holes of the base. Use regulating pieces of different thickness to have the pump regulated to the level position. As to the long 1600mm base, it has to regulate position three places:1 place is on pump end rather narrow side and the other 2 places are separately on the left and right two sides at the end of motor, use mechanical leveler to inspect installation along the pump axial line direction at the levelling flange place and it is necessary to have the flange on the horizontal branch pipe to be vertical, see Figure 3.1-1. The allowable maximum deviation is 0.1mm/m.

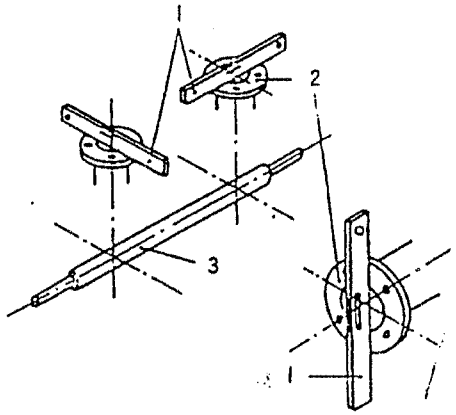


Figure 4.1-1

(1)Leveller
(2)Pump flange
(3)Shaft

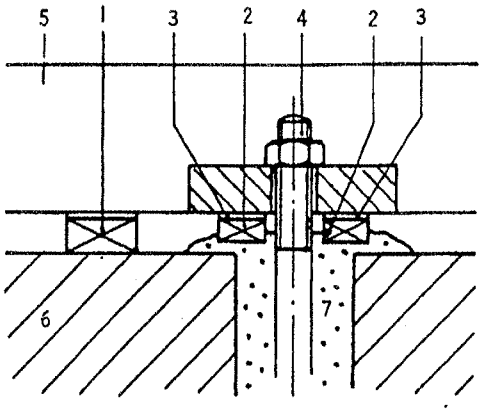


Figure 4.1-2

(1)Regulating pad
(2)Pad
(3)Thin pad
(4)Foundation bolt
(5)Base
(6)Foundation
(7)Concrete

4.1.7.2 When pouring to the foundation bolt hole to boild concrete, it is necessary to pile up a little bit above the hole and regulate the steel pads at the left and right sides on the concrete stack to enable to maintain a clearance between the base and the pad and then again use one or two pieces of thin pads of different thickness to fill(see Figure 4.1.1)

4.1.7.3 After the concrete has been solidified, screw the foundation bolts tightly .Again inspect the level installation and if there is any variation of the pump position, it has to rectify it again.

4.1.7.4 After rectification, use concrete to grout for the base (the concrete must not spill out). After solidify-cation, it will affect the rectification of the coupler, which will be described in 4.2.

4.2 Rectification of Coupler

4.2.1 Before rectifying coupler,ascertain the revolving direction of the motor according to the arrow direction of revolving direction on the pump.

4.2.2 As to the regulation of the elastic coupler, it is depending on the regulating pad placed under the motor to carry out careful rectification to the axis line and during the period of rectification, if it is careless, it will cause the coupler to be damaged and damage to the pump and motor bearings.

4.2.3 During installation and rectification of coupler, for details see the Figure of installation and instruction.

4.2.4 As to rectification on coupler which does not have middle section, it is able to use one precise straight foot to depend on the latitude of several points at will on the outer edge of the coupler to observe the parallelism with the shaft and use thick feeler gauge on several relative positions to control the stipulated distance between the two half couplers (see Figure 4.2-1).

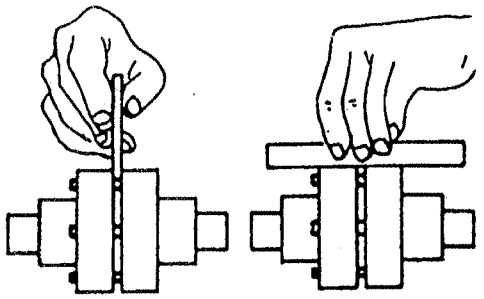


Figure 4.2-1

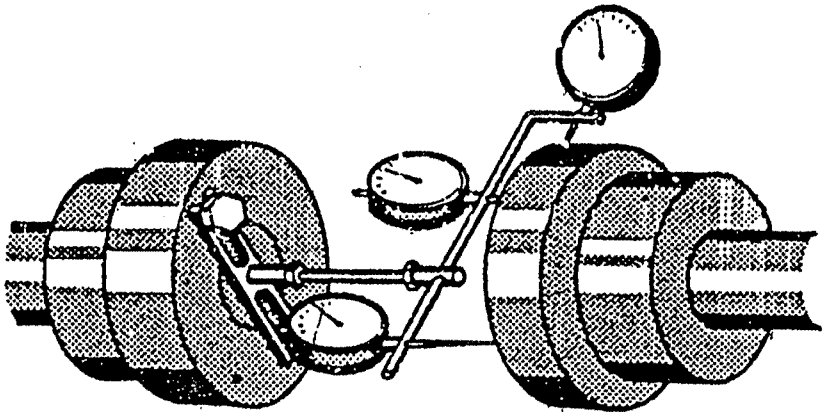


Figure 4.2-2

4.2.5 If it requires more precise rectification (under the condition of revolving speed of >3600 rpm or having the condition of middle section), it has to use dial gauge to rectify along the radial direction and axial direction (see Figure 4.2-2). At the place of maximum diameter, the allowable difference of the axial direction is 0.05mm and it is as far as possible to attain≤0.03mm; at the place of maximum diameter, the allowable difference of the rad alidifference is 0.1mm and it is as far as possible to attain≤0.05mm.

4.2.6 Under the condition of rather high operational temperature (about 130℃),it has to carry out precise rectification under the condition of hot running. If the allowable difference mentioned in the Article 4.2.5 is exceeded, the reason must be found out and eliminated. Under many conditions, the high load and torgue produced from swelling at the nearby pipeline are not allowed to bring to the pump flange. For details see Article 4.1.2.1.

Pipeline and Its Auxiliary Equipment

5.1 Suction and Discharge Pipeline

5.1.1 Brief Description

The diameters of suction and discharge pipes of the installation are usually calculated according to the flowing speed of liquid in the pipeline of suction, which is about 2m/S and the flowing speed of liquid in the pipeline of discharge, which is about 3m/S, which have been ascertained in the technological design (the standard diameter of discharge pipe of usual installation is greater than the standard diameter of suction pipe of the pump),therefore at here only certain practical problems, which must be considered during installation of pipeline, are given.

5.1.2 Installation

5.1.2.1 Supporting Pipeline. Thus, it will not cause the in and out pipes of the pump to deform too much which is produced from the force and moment caused by weight of pipeline and thermal stress. The connecting flange of the pipeline must be in parallel with the pump flange.

5.1.2.2 During installation of level pipeline, the diameter of the pipe on the liquid in end must be increased gradually towards the end part and the diameter of pipe at the liquid out end (the end connected with the pump) must the decreased gradually towards the end part and thus it is able to prevent from producing air bag.

5.1.2.3 Design the in and out pipes which benefit flowing when it changes from small pipe diameter to big pipe diameter, it needs to transit gradually and its rule is: the length of the cone transiting section is equal to 5-7 times of the standard diameter difference.

5.1.2.4 As to the connection of flanges, it is not allowed that the sealing pad between the flanges covers the passage of pipeline.

5.1.2.5 It has especially to take notice of the irregular transition pipe section and short bent in the suction and discharge pipelines, because at these positions, the resistance of pipeline will be increased, which should be avoided to use as far as possible. As to the place of suction mouth of the pump, the great pipeline resistance will enable the entrance pressure to decrease. If the pressure is too low, it will cause to produce air corrosion at the place of entrance of the impeller.

5.1.2.6 Under the condition of installing several pumps, in addition to the spare pump connected in parallel, it has to provide independent suction pipeline for each pump. The spare pump and the relative pump may have common suction pipeline, as it is because that during operation it is all along only to use one pump.

5.1.3 Cleaning of Pipeline

5.1.3.1 Before starting, all dirts and sundries in the pipeline system must be cleaned away seriously. As to the welded parts, the metal protruding matters of the welded part must be cleaned away.

5.1.4 Test of Static Water Pressure

5.1.4.1 It has to inspect the pipeline to see whether it is sealed and then carry out static water pressure test according to standard requirement.

5.1.5 Pipe Joints

The standard through diameter of the pipe joint must be the same as the standard through diameter of the pipeline. If the standard through diameters of the in and out pipes of the pump are smaller than the standard through diameters of the pipe joint, it has to install cone transition section between the two. As to the globe valve in the supplying pipeline, it is not allowed to have it directly connected with the pump to avoid the phenomenon of turbulent flow of liquid to affect the suction cavity of the pump. In order to avoid air bag, during installation of globe valve, its hand wheel axle must be towards the side or downward.

5.2 The auxiliary equipment (measuring instruments of pressure and temperature etc.) should be suitable for use of control and maintenance (cooling, heating, flushing and sealing etc. of the pump. The auxiliary equipment needed has to be ascertained according to pump type number and the condition of operation.

If the pump and auxiliary equipment provided are suitable for use, the following condition must be considered before installing auxiliary equipment at the operation site:

——The pressure gauge has to be installed on the support and through ϕ 8 measuring pipe, to be connected to the in and out pipes of the pump or the measuring point of the nearby pipeline. In order to ensure that it is able to stop the pressure gauge and to drain, at the front of the pressure gauge, a valve must be installed.

——The thermometer must be directly inserted into the measuring point and on the liquid sensitive position, the depth of inserting is 40mm. Under the condition of that the pressure is greater than 1.6Mpaa, it has to use thermometer carrying with protecting pipe.

——The liquid discharged by the pump is able to pass through long pipe to discharge to the liquid receiving groove at the base or to discharge to the pipeline collecting leaking liquid. In the leaking liquid pipeline, it has to install one valve which is at less equal to the standard pressure of the pump body.

——The leaking liquid of the mechanical sealing is also able to drain through long pipe to the liquid collecting groove at the base or to drain to the leaking collecting pipeline.

For pump which is needed to carry with cooling system, it has to arrange water supplying pipeline of cooling water at the lowest position of the cooling cavity body and to arrange water discharging pipeline

of cooling water at the highest position.In the water supplying pipeline,a regulating valve must be installed and in the water discharging pipeline of enclosed type system, it has to install one flow indicator and in the enclosed type system, the water discharging pipeline must be passing through the water discharging funnel to lead.

For pump which is needed to carry with heating system, in the heating pipeline, the water supplying pipeline must be arranged on the highest position and on the water supplying pipeline, it has to install a regulating valve. Drainage is through the liquid collecting pipeline.

As to the mechanical sealing auxiliary system, it must be executed according to the system given in the drawing. If the pipeline is led to the heat exchanger, pressure sensor or sealed groove, it has to provide an air discharging hole at the place of the highest point of the pipeline. Under the condition of that the difference of temperature is circulating, the diameter of its pipeline must be minimum 3/4" , and it is better to be of 1" . As to the flowing circuit, it has to arrange from continuously ascending way and it is not allowed to have apparent bending.

According to the structure of mechanical sealing, if it is requested that the cooling or flushing is secondary, it has to install rapid cooling installation.

Control of minimum amount of flowing. When the rate of flow of the liquid transported is situated below the point of the stipulated minimum rate of flow, on the liquid it will occur to be too hot at the middle till vapourizing and at this time, the impeller and the place of the mouth ring will be seriously damaged, which will lead to check and at the same time will lead to damage of mechanical sealing. In order to avoid occurance of this phenomenon, it has to establish an installation of minimum rate of flow to control the liquid transported all along to maintain to be above the minimum rate of flow stipulated.

Installation for control of minimum rate of flow-constant bypass pipe. Between the exit flange of the pump and the stop valve in the discharging pipeline, a bypass pipeline led to the supply tank is connected and a throttle or a stop valve is installed in the pipeline to limit the rate of flow of flowing.

The installation for control of minimum rate of flow is not within the limit of supplying goods of the pump manufacturer and it has to be provided by the user itself. In the opening type system, before starting, the stop valve installed in the installation for control of minimum rate of flow must be closed down.

Operation

6.1 Starting

6.1.1 Before the first time of starting

6.1.1.1 Use light oil (not to use petroleum product) to flush the bearing support cavity body and clean it thoroughly and then fill lubricating oil up to the middle of the oil view window.

6.1.1.2 Check the rectification of the coupler

6.1.1.3 Check the shaft sealing (Article 6.2)

6.1.4 Filling of Pump

When the pump is situated at the condition of invert filling or with pressure (higher than the atmospheric pressure): open the stop valve in the suction pipeline and open the pump and the mechanical sealing exhaust valve; slowly turn the rotor of the pump and when the liquid transported flows without carrying with air bubbles, close the exhaust valve.

When the pump is situated at the condition of suction: in the suction pipeline, there must be installed bottom valve. Open the stop valve in the suction pipeline and open the pump and the mechanical sealing exhaust valve; use the liquid transported to fill pump; slowly turn the pump rotor; when the transported liquid flows without carrying with air bubble, close the exhaust valve.

6.1.1.5 Through instantaneously connecting the motor, inspect whether the turning direction and running are normal.

6.1.1.6 If all are normal, open the stop valve in the installation for control of minimum rate of flow and regulate the throttle valve up to the point of minimum rate of flow stipulated and have it locked tightly.

6.1.2 Starting and Running of pump

6.1.2.1 Open the valve in the pipeline of auxiliary equipment (open after the cooling pipeline has been started).

6.1.2.2 Close the stop valve in the exhaust pipeline, start the motor and then slowly open the stop valve in the exhaust pipeline till the pressure difference is decreased to the value stipulated in the data list.

Warning: Difference of pressure must not be lowered than the designed point too much and also must not have pressure fluctuation in the system.

Attention: The value of the pump exit pressure gauge is equal to the difference of pressure plus the value of pump entrance pressure gauge.

6.1.2.3 Monitor the reading on the ammeter and it has to ensure that the current must not exceed the value stipulated in the nameplate of performance on the motor.

6.2 Stopping

6.2.1 Close the stop valve in the exhaust pipeline.

6.2.2 Stop the motor and at the same time take notice of the actual condition of the slowly stopping of the rotor.

6.2.3 If the pump is in the condition of suction and there is no measure to prevent from starting, it has to close the stop valve in the suction pipeline.

6.2.4 Close the valve in the auxiliary equipment pipeline (close the water cooling valve, after the pump has been cooled down).

6.2.5 Under the condition of having the phenomenon of condensation, the phenomenon of freezing or stopping to use over a long period of time, the liquid in the pump body and in the cooling cavity must be removed.

6.3 Control of Operation.

6.3.1 Inspection of Operation Point (designed point)

At the period of starting at the first time, it has to inspect the following parameters in detail:

Measure out the revolving speed.

Read out the value of the pressure gauge on the exhaust pipe of the pump and minus the value of the pressure gauge on the suction pipe. The value of pressure after being calculated out according to the following formula must tally with the lift stipulated in the nameplate of the pump under given rotational speed.

$$H(m)=\frac{1020\cdot P(MPa)}{\rho\ (kg/m^3)}$$

$$P(MPa)=\frac{H(m)\cdot \rho\ (kg/m^3)}{1020}$$

In the formula: H—pump lift.

P—pressure difference, pressure difference is equal to the value on exhaust pressure gauge of the pump minus the value on the suction pressure gauge of the pump.

r—Specific gravity of the liquid transported.

The pressure should not be lower than the above mentioned value, otherwise it will exceed the maximum allowable rate of flow and even it is able to interrupt flowing.

6.3.2 Ascertainment of Rate of Flow

Calculate out the lift according to the pressure gauge and then ascertain the rate of flow on the given performance curve of the pump. As to the specific method, see Figure 6.3-1. On the performance curve, find out the calculated value of lift, ascertain the point of intersection of the horizontal line and the curve H, read out the value of rate of flow under the curve of the point of intersection and this value is the rate of flow needed to ascertain.

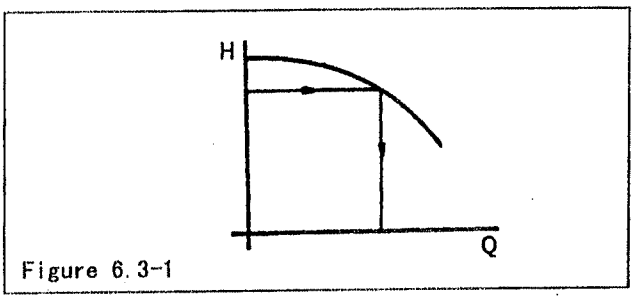


Figure 6.3-1

(1) Lift (2) Rate of flow m^3/h

Maintenance

7.1 Pump

7.1.1 During the period of operation, inspect the nature of smoothness and steadiness of the running of the pump unit and whether there is any phenomenon of vibration and take notice of the abnormal running noise. Under the condition of not knowing the reason of occurrence of noise and trouble, it should stop immediately to find out the reason and eliminate it.

7.1.2 Periodically inspect the rectification of coupler(at least once a year) to eliminate deformation and to avoid damage.

7.1.3 If it has the following auxiliary equipment, inspection has to be carried out during the period of operation:

Cooling: Inspect the rate of flow and temperature.

Heating: Inspect the temperature and pressure.

Flushing of sealing: Inspect the pressure, temperature and rate of flow.

7.1.4 Under the condition of having spare pump, in order to ensure the state that it is able to put into operation immediately, it has to start these pumps at fixed time. Under the condition of stopping over a long period of time, the liquid transported has to be removed and if there is cooling water, it should also be discharged.

7.1.5 If the performance of the pump decreases not because of that the pipeline system is changed nor the change of the resistance of the pipeline is caused by water scale, the decreasing of the performance of the pump is possibly caused by wearing of the internal parts of the pump. At this time, it has to examine and repair the pump and to replace the parts already worn out (as to examination and repair see this Section).

7.1.6 As to all operation conditions and details regarding lubrication of pump and examination and repair etc., it should be recorded in detail and formed in files.

7.2 Stuffing Sealing

7.2.1 Structure

According to the liquid transported and the condition of operation, the stuffing in the stuffing box body can be arranged in different form (as to the arrangement of the pump provided, see shaft sealing sectional

drawing):

Structure carrying with water sealing ring:

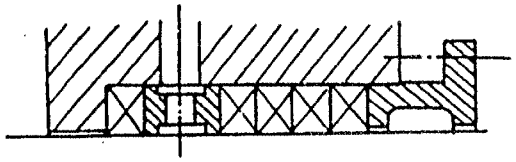


Figure 7.2.1-1

The water sealing ring equipped with sealing liquid is arranged in the middle part of the stuffing cavity. When over pressure at the shaft sealing place 0.02Mpa and when the liquid lubricating is abominable, it has to have sealing liquid. The minimum pressure of the sealing liquid should be 0.1MPA greater than the pressure at the shaft sealing.

Structure carrying with stuffing gland cooling:

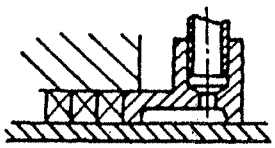


Figure 7.2.1-2

In order to avoid that on account of the decrement of pressure at the axle sealing place, it thus enables the hot liquid (such as water above 110℃) to produce evaporation, at the place of stuffing gland it has to cool. As to the quantity of cooling water and pressure, they must be regulated by the regulating installation (during 0.02Mpa, it is about 0.05m^3/h). As to the mixed liquid of cooling water and the liquid leaked, the higheast temperature allowed is 40℃.

7.2.2 State of Operation

The function of the stuffing box body is to have the pressure (internal pressure of liquid) brought to the liquid by the stuffing to deliver to every direction, therefore the stuffing must be filled fully in the space between the stuffing cavity and shaft sleeve (with the exception of small amount of radial clearance) and thus it will greatly check the leakage between the static parts and rotating parts. In order to obtain good function, it has to ensure the lubricating nature and the heat transmission between them.

7.2.3 Stuffing

The stuffing has been filled well before the pump leaves the factory. If it is unable to carry out the first time of starting within 12 weeks after it being transported to site of operation, it has to take out the original stuffing and has it replaced with new stuffing within a short period before trial running.

Before installing stuffing, wash the axle sleeve and the stuffing cavity, inspect the surface of the shaft sleeve to see whether it is normal and should inspect the jumping of the surface of the axle sleeve, the allowable difference of which is as follows:

When the pressure of shaft sealing is less than or equal to (≥)2.5Mpa, the jumping of which is equal to (=)0.05mm, the coarseness of surface is equal to (=)0.4;

When the pressure of shaft sealing is greater than(>)2.5～5.0Mpa, the jumping of which is equal to (=)0.03mm, the coarseness of surface is equal to (=)0.2;

When the pressure of shaft sealing is greater than(>)5.0～10.0Mpa, the jumping of which is equal to (=) 0.02mm, the coarseness of surface is equal to (=)0.2.

For the sake of filling again, it should provide with sufficient stuffing. When use stuffing gland to have the stuffing rings to press into the stuffing cavity successively, it has to stagger mutually 90° between the cutting open sections of the stuffing rings.

On the empty pump which has not been filled, it has to press the stuffing gland evenly and tightly and not aslant. Use check and measure instrument to inspect the distance between all sides of the gland flange and the stuffing cavity to enable them to maintain evenly and then loose the stuffing gland and screw on allen nuts.

7.2.4 Monitoring

As to the stuffing sealing, it has to limit its amount of leaking to ensure good cooling, lubricating and stability of running. As to the condition of that the temperature of the liquid leaked is below 60℃, its amount of leaking should be limited to 1 l/h (equal to one drop per minute) to 15 l/h (equal to the amount of the dilute liquid penetrating through 2mm hole)

As to pump of pressure of shaft sealing ≤1.0Mpa:

When there is rather great amount of leaking, it has to press the stuffing gland evenly and tightly and not aslant nor to use strength too much. If after again pressing tightly, the amount of leaking is still rather great and the temperature of the liquid leaked exceeds the allowable limit, it has to replace the stuffing ring again.

Pump of pressure of axle sealing＞10 bar:

When there is rather great amount of leaking, it is not allowed to press tightly the gland again, otherwise it will lead the shaft sealing to damage. When this kind of condition appears, it has to replace stuffing ring again.

After each time of filling new stuffing, it has to go through a wearing-in period and during this period it has to take notice and inspect often and after the wearing-in period, its amount of leaking will be decreased to some extent.

7.2.5 Material of Stuffing

As to the material of stuffing, it has to be selected and fixed according to the liquid transported and parameter used. Under general condition, the material of stuffing provide is soft graphite and carbon fibre and for special order, it is also able to give clear indication of other material.

7.3 Single Mechanical Seal

In order to ensure to have good sealing performance and steadily running, between the two sealing rings(moving ring and static ring/0, it has to maintain a liquid film, therefore the medium transported should satisfy the following conditions:

—Enough lubricating speciality.

—The vapourized temperature is greater than the working temperature.

—The medium in the seal ng ring district does not contain admixture and grain.

The sealing auxiliary system has:

—Self flushing.

—Cooling.

—Heating.

The safeguarding of single end face mechanical sealing chiefly includes monitoring on auxiliary system, amount of leaking and temperature of sealing. Under the condition of normal circulating flushing, the temperature of flushing liquid is not allowed to be higher than the temperature nearly the pump body. Under the condition of cooling or heating, its pressure, rate of flow and temperature should be executed according to the stipulated value.

Attention: The allowable amount of leaking of the single end face mechanical sealing is $10m^3/h$. When the amount of leaking is rather great ($\geqslant 50cm^3/h$). it can be ascertained that the sealing part was damaged and it should be immediately inspected and repaired. If the sealing ring (moving ring or static ring) worn out is unable to be polished again, it has to replace with new one. At each time of installing and dismantling sealing, the static sealing part (such as 0 ring) must be replaced with new one.

7.4 Double Mechanical Seal

The axle sealing is organized by two (one internal and one external) mechanical sealings arranged back to back. The sealing liquid must be transported into the space between the two sealings and the pressure of medium transported near the sealing place (minimum higher 0.1~0.3Mpa and maximum higher 0.7~1.0Mpa) and thus it will have the specialities as follows:

—On account of increasing contact pressure, it will enable to have more better sealing nature between the sealing ring contact faces.

—There is good lubricating nature between sealing rings.

—To prevent the medium transported from leaking out.

Double end mechanical sealing auxiliary system has to complete the following assignment during the process of operation:

—Forming the required overpressure.

—Circulation of sealing liquid.

—Filling sealing liquid during operation.

The maintenance of double end face mechanical sealing chiefly includes filling of the sealing liquid in time and monitoring the sealing and the temperature of the auxiliary system. The in and out pipeline must be ensured to have certain difference of temperature.

Attention: When there is rather great loss of the sealing liquid, it can be concluded that the sealing part was damaged and it should be examined and repaired immediately. If the sealing ring (moving ring or static ring) worn out is unable to be polished again, it must be replaced with new one. During each time of installing and dismantling sealing, the static sealing part (such as O type ring) must be replaced with new one.

7.5 Double Mechanical Sealing in "tandem" arrangement

The mechanical sealing is organized by two pairs of sealing rings (moving or static ring) arranged in series connection. In order to ensure to have good sealing performance and smooth running, there must be maintained a layer of liquid film between the two sealing rings (moving ring and static ring), therefore the medium transported has to satisfy the following conditions:

—Enough lubricating nature.

—Vapourized temperature is greater than the working temperature.

—Medium within the sealing ring district does not contain admixture and grain.

The sealing auxiliary system has:

—Flushing

—Cooling

—Heating

—Whirlpool separator or filter (under the condition of transporting liquid containing admixture or grain)

Maintenance of serial type mechanical sealing chiefly includes monitoring of auxiliary system, amount of leaking and temperature of sealing. Under the condition of normal circulating flushing, the temperature of flushing must not be higher than the temperature near the pump body. Under the condition of cooling or heating, as to its

pressure, flow and temperature, if has to execute according to the stipulated value.

Attention: The allowable amount of leaking of serial type mechanical sealing is 10cm3/h. When the amount of leaking is rather great ($\geqslant$ 50cm³/h), it can be concluded that the sealing part was damaged and it should immediately carry out examining and repairing. If the sealing ring (moving ring or static ring) worn out is unable to be polished again, it has to replace with new one. On each time of dismantling and installing sealing, the static sealing part (such as O type ring) must be replaced with new one.

7.6 Lubrication

7.6.1 Lubricaltion of Bearing

7.6.1.1 The bearing needs suitable amount of lubricating oil to lubricate and moreover in the lubricating oil it is not allowed to contain any admixture and acid etc.

7.6.1.2 In the process of running, the bearing itself heats, which takes a very important action on the variation of viscosity of lubricating oil and the viscosity will directly affect the performance of lubricating. In order to ensure the bearing to have good lubricating condition, it is requested that within the limit of operational temperature of the bearing, the dynamic viscosity of the lubricating oil is at least 12mm²/S, therefore as to the viscosity of lubricating oil, it has to select as follows:

Temperature of Bearing Support℃	Dynamic Viscosity mm²/S	Lowest Flash Point℃
>50~75	υ 50=25	145
>75~85	υ 50=36	145

7.6.1.3 Under the condition of for the first time to make available to use or again for use after examining and repairing of bearing after the pump has been running for 10~15 hours, remove all lubricating oil, wash the running part of the pump and then again replace with lubricating oil and put it into normal operation. During normal operation, it has to replace the lubricating oil periodically according to the following cycle:

Temperature of Bearing Bracket℃	Cycle of Replacing oil(month)
>50~75	12
>75~85	6

7.6.1.4 Periodically inspect the lubricating oil in the bearing housing or the temperature of bearing cavity and the allowable limit is as follows:

Inspecting measuring point / Scope	Situated at the place of the bearing box sur face nearby the bearing	Place of outer ring of bearing	Oit temperature inside the bearing box
Normal long period running	⩽80℃	⩽90℃	⩽70℃
It should take notice of	80~⩽90℃	90~⩽100℃	70~⩽80℃
The machine uintshould be cut off	90~⩽100℃	100~⩽110℃	80~⩽90℃

7.6.2 Fill Oil of Permanent Position Oil Cup

7.6.2.1 Fill lubricating oil through the oil hole on the bearing box till the branch pipe of the permanent position oil cup begins to be filled with oil. Use the same kind of lubricating oil to fill into the permanent position oil cup as shown in Figure 7.7.2-1 and then cover again the permanent position oil cup. Repeat carrying out the above mentioned filling permanent position oil cup and covering the permanent position oil cup till 2/3 of the permanent position oil cup is filled with lubricating oil, as shown in Figure 7.7.2-2. During operation, it has often to inspect the condition of supplying of oil of the permanent position oil cup and if it is discovered that the position of oil descends, it has to supplement lubricating oil immediately. If the sealing of the permanent position oil cup itself ceases to be effective and leaks oil, it needs to replace the permanent position oil cup.

7.7.2.2 If the oil position in the bearing box body descends,it has to add oil time through oilsupplying thank till it attains the above mentioned oil position.

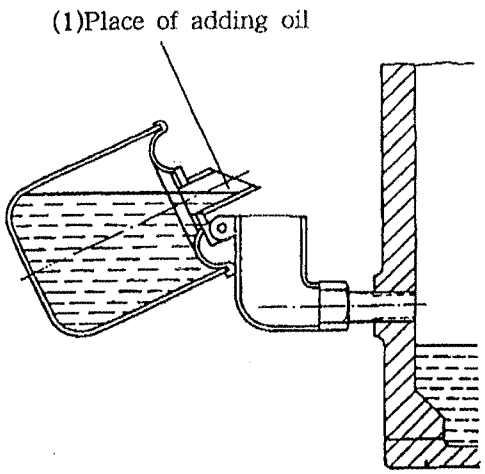


Figure 7.7.2-1

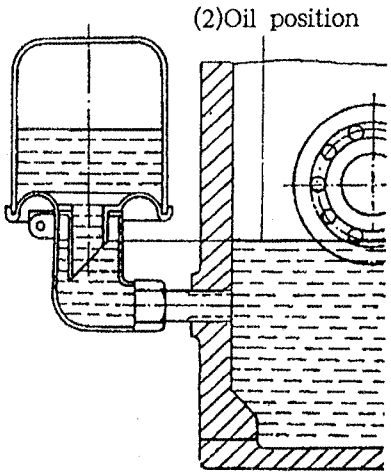


Figure 7.2.2-2

Repair

In order to avoid prolonging the cycle of stopping to repair, it is as early as possible to purchase the necessary spare articles and spare parts (such as easily worn out parts). During purchasing spare parts, it has to provide the manufacturer with definite kinds (names etc.) of parts, type number of pump and number of manufacturer (see sign of pump).

8.1 Dismantling

8.1.1 Preparatory Work

—Close inlet and outlet valves and ensure that it is not allowed to open the valve under the condition of without permission.

—The motor is at the state of stop and is prevented from starting.

—Empty the transported medium and lubrication oil in the pump.

—Dismantle the protection cover of coupler and coupler.

—Dismantle all instruments and auxiliary equipments and pipelines.

8.1.2 Dismantlement of Detachable Units

—Draw out the shaft sleeve.

—Draw out the semi-coupler at the pump end.

—When the bearing support carries with air cooling, dismantle fan cover and fan.

—Dismantle the deflector.

—Dismantle the front and rear glands of bearing and dismantle the tight parts of bearing at the end of coupler.

—Use the hammer with protective rubber cover to knock out the shaft from the side of the coupler.

—Draw out the bearing.

—As to the condition of that the bearing support is carrying with water cooling, take out the cooling water cover and

— Loose the foot supporting bolts on the base.

— Use dismantling tool to pull out detachable units (including bearing unit with shaft, pump cover and impeller). Under the condition of big unit, it is able to use hoisting hock to carry out hoisting dismantling on the hoisting screw of the bearing support.

8.1.3 Dismantlement of shaft sealing

As to the stuffing sealing or mechanical sealing:

—Lock the pump axle fixedly, unscrew the impeller nut.

—Pill out impeller.

—Loose the external parts of the shaft sealing (mechanical sealing gland or stuffing gland).

—Separate the pump cover from the bearing support and draw it out. Again inside of the cavity of the shaft sealing on the pump cover, dismantle the remaining sealing parts.

—Under the condition of mechanical sealing, draw out the axle sleeve and the turning sealing parts altogether.

8.1.4 Dismantlement of Pump Shaft

wash cooling cavity.

8.2 Inspection of internal Parts

Inspect all easily worn out parts, if there is any damage, it has to process again or replace with new one.

8.2.1 Impeller and Clearance

Inspect the impeller damaged, by corrosion and wear and if there is serious damage,it has to replace with new one. Measure and fix the clearance between the impeller wearing ring and pump body wearing ring and if it exceeds the limited scope, it has to replace with new one. The allowable clearance between the impeller wearing ring and the pump body wearing ring is as the following list:

Diameter at the place of Clearance of the impeller Mouth ring	<75	75～140	140～200	200～300	320～400	400～600
Radial clearance (new parts)	0.3 0.5	0.4 0.6	0.5 0.7	0.6 0.8	0.7 0.9	0.8① 1.0②
Maximum radial clearance (used parts)	0.9 1.5	1.2 1.8	1.5 2.0	1.8 2.5	2.0 2.8	2.5① 3.0②

①Cast iron or soft nitrided steel. ②Stainless steel.

8.2.2 Alignment of Shaft

At the place of the center holes at the two ends of the shaft, flx position to install and carry out alignment test on shaft (maximum allowable deviation 0.025mm). As to the axle having radial jumping being 3 times of the allowable value, it is usually that it is unable to use again.

8.2.3 Shaft Sealing Parts

8.2.3.1 Mechanical Sealing

—On the surface of the sealing ring (moving ring and static ring). It is not permitted to have any scratch and if there is any scratch and if there is any scratch, it has to polish again and under the condition of having deep groove or crack, it has to replace with new sealing ring.

—Inspect the surface of the shaft sleeve (especially on the position of the revolving unit) to see whether it is level and bright and clean, if there is any question of scratch, it has to grind again or to replace with new shaft sleeve.

8.2.3.2 Stuffing Sealing

—Inspect the shaft sleeve and if its diameter is greater than the calculated diameter minus 1mm, it is able to process again to repair and to match stuffing ring according to new diameter and under the condition of high pressure (exceeding 1.0Mpa), it has to replace the axle sleeve with new one.

—Inspect the clearance between the stuffing gland and the shaft sleeve and control according to the following List.

Pressure at the place of shaft sealing		≤1.0MPa	>1.0MPa
Diameter clearance at the place of stuffing gland	Normal	1mm	0.6mm
	Maximum	2mm	1.2mm

8.2.4 Bearing

—Use light oil to wash bearings and if there is any damage, it has to replace it with new bearing.

8.3 Reassembling

8.3.1 Preparatory work

—Wash the pump parts.

—Select suitable lubricating oil.

—As to the pump of opening type impeller, use new sealing rings to install front and rear wear resistance boards preliminarily and as to the bearing support of water cooling, it has to install the cooling cavity preliminarily.

8.3.2 Asembling of Pump Shaft

—Have the bearing heated up to 80℃ in the oil trough and slip it on the shaft and then fix it.

—Have the axle carrying with bearing inserted into the bearing support from the side of coupler and cover it with bearing gland; before slipping on, it has preliminarily to paste the oil resistant sealing paste to the sealing face of the bearing gland.

—Install throttle pan and when it is of air cooling, it has to in stall fan and fan cover.

—Press in the semi-coupler of the pump end and as to coupler of cast iron bore≤100mm and steel bore≤50mm, it has to adopt cold fit and as to coupler of cast iron bore>100mm and steel bore >50mm,it has to adopt hot fit (to heat again up to 80℃ in the stove).

8.3.3 Assembling of shaft sealing

8.3.3.1 Mechanical Sealing

—Have the unit carring with sealing rings (moving ring and static ring) plugged into the sealing gland, then place the auxiliary sealing parts in and then press them completely onto the shaft.

Have the pump cover installed on the bearing support and screw it tightly and at the same time plug in the mechanical sealing and screw it tightly.

8.3.3.2 Stuffing sealing

—Have the stuffing gland and shaft sleeve slipped on the shaft and if there is water sealing ring, it has to slip it on at the same time.

—Have the pump cover put on the bearing support and screw it tightly; install in the stuffing ring and press the stuffing gland on.

8.3.4 Final Assembling of Detachable Unit

—Install impeller and screw the nuts of impeller tightly. The nuts of the impeller depend on the steel wire screw sleeves installed inside to prevent from loosening. After going through 5~10 times of dismantling and installing, the function of automatically locking tightly of the steel wire screw sleeves will be descended and it has to replace with new steel wire screw sleeves.

—Have the sealing flat pad placed into the pump body.

—Install the detachable unit and screw the double head screw pillars of the pump body and nuts tightly.

—Have the foot supporting screw pillars on the base screwed tightly.

8.3.5 Final Assembling

—Connect the auxiliary pipeline and instruments.

—Have the coupler connected to the driver and correct it, for details see Article 3.2.