

Elementary Mechanical Knowledge

1. What is a pump?

Pump is a kind of machinery that converts the mechanical energy of the prime mover into the energy pumping liquid.

2. What is power?

Power is the amount of work done in unit time.

3. What is effective power?

Effective power is the actual power of the liquid obtained through the pump in unit time apart from the energy loss and consumption of the machine itself.

4. What is shaft power?

Shaft power is the power transmitted to the pump shaft by the motor.

5. Why is the power transmitted to the pump from the motor always greater than the effective power of the pump?

① During the operation of the centrifugal pump, a part of the high-pressure liquid in the pump flows back to the inlet of the pump, or even leaks out of the pump, so one part of energy shall be lost;

② When the liquid flows through the impeller and pump shell, one part of energy shall be consumed because of the changes of flow direction and velocity and the mutual impact between fluids;

③ One part of energy shall be consumed due to the mechanical friction between pump shaft and bearing and shaft sea;

Therefore, the power transmitted by the motor to the shaft is always greater than the effective power of the shaft.

6. What is the gross efficiency of the pump?

The ratio of the effective power of the pump to the shaft power.

7. What is the flow rate of the pump? And the symbol ?

Flow rate refers to the amount of liquid (volume or mass) flowing through a certain section of the pipeline in unit time. The flow rate of the pump is represented by 'Q'.

8. What is the pump head? And the symbol ?

The head refers to the increase in energy obtained per unit weight of fluid. The head of the pump is represented by 'H'.

9. What are the features of chemical pumps?

- 1) It can adapt to chemical process requirements;
- 2) High temperature and low temperature resistance;
- 3) Wear resistance and erosion resistance;
- 4) Reliable operation;
- 5) No leakage or little leakage;
- 6) It can transport liquid in critical state;
- 7) Resistant to capitation.

10. How many categories of mechanical pumps divided according to the working principle?

1) Vane pump. When the pump shaft rotates, the various impellers and blades are driven to transport liquid to pipeline or vessels with centrifugal force or axial force, such as centrifugal pump, vortex pump, mixed flow pump and axial flow pump.

2) Positive displacement pump. The liquid is transported through continuous change of the internal volume of the pump cylinder, such as reciprocating pump, piston pump, gear pump and screw pump;

3) Other types of pumps. Such as electromagnetic pumps transporting liquid with electromagnetism; pumps transporting liquid with energy of fluid, eg. jet pump, air lift pump, etc.

11. What to do before maintenance of chemical pumps?

1) The machine and equipment shall be stopped, cooled down, depressurized and power off before maintenance;

2) In case there is flammable, explosive, toxic and corrosive medium, the machine and equipment shall be cleaned, neutralized, replaced before maintenance, and starts only after passing the analytical detection;

3) In case of maintenance of equipment, machines and pipelines with flammable, explosive, toxic and corrosive medium or steam, the material inlet and outlet valves must be cut off and blind plates must be added.

12. The process conditions should be in place before maintenance of chemical pump?

1) Shutdown; 2) Cooling down; 3) Decompression; 4) Power off; 5) Displacement

13. What are the general principles of mechanical disassembling?

Generally, it should be disassembled in proper order, from outside to inside, from top to bottom, and the integral parts shall be disassembled integrally as far as possible.

14 . What is the power loss inside the centrifugal pump?

There are three kinds of losses: hydraulic loss, volumetric loss and mechanical loss.

1. Hydraulic loss: when the fluid flows in the pump, the resistance is smaller if the flow channel is smoother, or is greater. When the fluid enters in or exits from the rotating impellers, losses occurs due to collision and vortex. The above two losses are known as hydraulic loss.

2. Volumetric loss: the impellers are rotating while the pump body is static. A small part of the fluid in the gap between the impellers and the pump body flows back to the inlet of the impeller; In addition, a part of fluid flows back from the balance hole to inlet of the impeller inlet or leaks from the shaft seal. And a part of fluid leaks from the balance disc too in case of a multiple-stage pump. The above losses are known as volumetric loss;

3. Mechanical loss: during rotation, one part of power is consumed by the friction between the shaft and the bearing and the packing and the friction between front and back blind plates and the fluid. The above losses caused by mechanical friction are known as mechanical loss.

15. In production practice, what is the basis of the balance of the rotor?

The balance of the rotor could be found with static balance method or dynamic balance method according to the different revolutions and structures. The static balance of the rotating body can be solved with the static balance method. Static balance can only balance the center of gravity of the rotating body (the torque is eliminated), but cannot eliminate the unbalanced couple. Therefore, static balance method is suitable for disc-shaped rotating body with a smaller diameter generally. For a rotating body with a larger diameter, dynamic balance problem is more common and prominent, so dynamic balance treatment is necessary.

16. What is balance? How many types of balance?

1) Balance is the work eliminating unbalance of rotating parts or components.

2) Balance can be divided into static balance and dynamic balance.

17. What is static balance?

There are some special tooling, the front position of imbalance of the rotating part need to be measured without rotation, and the position and the amount of the balance force can be determined at the same time. This method of finding the right balance is called static balance.

18. What is dynamic balance?

Usually the operation conducted when the part are rotating, not only the centrifugal force generated by the eccentric weight need to be balanced, but also the couple moment formed by the centrifugal force need to be balanced, is called as dynamic balance. Dynamic balance is generally applied to mechanical parts with high speed, large diameter and particularly strict requirements of working accuracy.

19. When apply static balance to rotating parts, how to determine the eccentric orientation of the parts to be balanced?

Firstly, let the part to be balanced roll freely on the balance tooling for several times, and if the last rotation is clockwise, the center of gravity of the part must be at the right side of the vertical centerline (due to friction resistance). At this time, make a mark with a white chalk at the lowest point of the part, and then let the part roll freely, and the last rotation is in counterclockwise direction, the center of gravity of the part to be balanced must be at the left side of the vertical centerline. Similarly, make another mark with the white chalk, and the center of gravity recorded twice is the eccentric orientation.

20. When apply static balance to rotating parts, how to determine the amount of balance weight ?

First, turn the eccentric orientation of the part to the horizontal position, and add appropriate weight at the maximum circular point at the opposite and symmetrical position. When select the point adding the appropriate weight, shall consider whether the point can be weight balanced or weight loosen in the future, and can keep horizontal or oscillate slightly after adding the appropriate weight. Then reverse the part 180 degrees and maintain it in the horizontal. Repeat several times, after the appropriate weight is determined to be unchanged, remove the appropriate weight and weigh it, thus the gravity of the balance weight is determined.

21. The types of imbalance of the mechanical rotor?

Static imbalance, dynamic imbalance and mixed imbalance.

22. How to measure the bending of pump shaft?

If the shaft was bent, it would cause imbalance of the rotor and wear of the dynamic and static parts.

Place the bearing on a v-shaped iron if it is small, and on a roller support if it is big, and the v-shaped iron or the roller support shall be stable. Then place the dial indicator on with the measuring bar pointing to the axis, and then slowly rotate the pump shaft. If there is bending, there are a maximum and a minimum readings revolution. The difference between the two readings indicates the maximum radial runout of shaft bending, also known as runout. The bending degree of the shaft is one-second of the runout. Generally, the radial runout of the shaft is not more than 0.05mm in the middle, and more than 0.02mm at both ends.

23. Three types of causes of mechanical vibration ?

- 1) Structure: caused by defects in manufacturing and design;
- 2) Installation: mainly caused by improper assembling and maintenance;
- 3) Operation: caused by improper operation, mechanical damage or excessive wear.

24. Why is misalignment of the rotor an important reason for abnormal vibration of rotor and early damage of bearing?

Due to influence of factors including the installation error between rotors, rotor manufacturing, deformation after load, ambient temperature change and etc, poor alignment of rotors may be caused. The shaft system with rotors of poor alignment, the force of the coupling changes, thus, the actual working position of rotor journal and bearing changes, then not only the working status of the bearing changes, but also the the natural frequency of rotor shaft system decreases. Therefore, rotor misalignment is an important reason for abnormal vibration of rotor and early damage of bearing.

25. What is the standard for measuring and rechecking the ovality and taper of shaft diameter ?

Measure and check the ovality and taper of the shaft diameter of the sliding bearing which should meet the technical requirements, generally not greater than 1/1000 of the diameter. The ovality and taper of the shaft diameter of the rolling bearing are not greater than 0.05mm.

26. What should be paid attention to when assembling chemical pump?

- 1) Whether the pump shaft is bent or deformed;
- 2) Whether the balance of the rotor meets the standard;
- 3) Gap between impeller and pump case;
- 4) Whether the amount of compression of the buffer and compensation mechanism of the mechanical seal meets the requirements;
- 5) Concentricity of pump rotor and volute;
- 6) Whether the center line of the flow channel of the pump impeller and the one of the volute are aligned;
- 7) Gap adjustment between bearing and end cap;
- 8) Gap adjustment of sealing part;
- 9) Whether the assembly of the motor of transmission system and speed transmission (increase and decrease) meets the standard;
- 10) Coaxiality alignment of the coupling;
- 11) Whether the clearance of the impeller ring meets the standard;
- 12) Whether the tightening force of connecting bolts of each part is appropriate.

27. What is the purpose of pump maintenance? What about the requirements?

Purpose: eliminate the existing problems in the pumps after long-term operation through maintenance. The requirements are as follows:

1. Eliminate and adjust the large gap in the pump caused by wear and corrosion;
2. Clean dirt and rust in the pump;
3. Repair or replace unqualified or defective parts;
4. Shall pass the rotor balance test;
5. Check the coaxiality between the pump and the driver which shall meet the standards;
6. Test qualified, document is complete, and the process production requirements are met.

28. What is the reason for the excessive power consumption of the pump?

- 1) The total head is inconsistent with the pump head;
- 2) The density and viscosity of the medium are inconsistent with the original design;
- 3) The pump shaft is inconsistent with the prime mover axis or is bent;
- 4) There is friction between the rotating part and the fixed part;

- 5) Impeller ring is worn;
- 6) Improper installation of seals or mechanical seals.

29. What are the causes of rotor imbalance?

- 1) errors in manufacturing: uneven density of material, different axis degrees, out-of-roundness, uneven heat treatment;
- 2) Incorrect assembly: the center line of assembly parts is misalignment with the axis;
- 3) Rotor deformation: uneven wear cause shaft deformation under operation and temperature.

30. What is a dynamic unbalanced rotor?

There is a rotor with two force couples not in the same line because of equal power, opposite direction and unbalanced mass points.

31. How to prevent evacuation and cavitation during operation?

Evacuation: There are gas and liquid existing in the pump, the pump cannot work, and the flow and pressure tend to zero.

Cavitation: It occurs in the pump during operation, and comes from the medium in the pump, the flow and pressure change and drop, hydraulic impact occurs.

Generally, evacuation of the pump refers to a kind of cavitation phenomenon that occurs in the pump, it is caused by change in operation and process mostly, and seldom caused by the inhalation of gas due to the leakage of pipeline.

In the process of operation, shall start with stabilizing the process operating conditions. The lower limit of the operating temperature and the operating pressure should be taken, and the flow rate of the pump should be moderate during operation to reduce possibility of large changes in pressure and temperature as much as possible, to avoid or control the occurrence of cavitation. The suction pipeline of the pump should prevent the retention of gas, and the inlet of the standby pump should be closed if the inlet pressure is negative.

32. What is moveable fit and stationary fit? What is the obvious difference between them?

- 1) moveable fit: the fit formed in case the actual size of the hole bigger than the actual size of the pump;
- 2) Stationary fit: the fit formed in case the actual size of the shaft bigger than the actual size of the hole;

3) Obvious difference: moveable fit: there is relative movement between the shaft and the hole; Stationary fit: there is no relative movement between the shaft and the hole.

33. What are the four essential requirements for equipment maintenance?

Neat, clean, lubricating and safe

34. What is the working principle of labyrinth seal?

Labyrinth seal: it is composed of several annular sealing teeth arranged in order. A series of throttling gaps and expansion spaces are formed between the teeth and the rotor, the fluid passes through many tortuous channels, and receives great resistance after several throttling, thus the fluid is difficult to leak and the purpose of sealing is achieved.

35. What is interchangeability of parts? What is the main function?

1) Interchangeability of the parts: the parts can be exchanged and used mutually, and can meet the various index requirements of the original parts.

2) It contributes to convenience of maintenance, reducing maintenance time, improving equipment utilization and working efficiency.

36. What is a power pump?

The power pump continuously transmits energy to the conveyed liquid to increase its velocity kinetic energy and pressure energy and potential energy. Mainly the velocity increased, and then it reduced, most of the kinetic energy is transformed into pressure energy, transport through the increased pressure of the conveyed liquid.

Such as: 1) vane pump, including centrifugal pump, mixed flow pump, axial flow pump, vortex pump, etc;

2) Jet pump, including gas jet pump, liquid jet pump, etc

37. What is a positive displacement pump?

In the process of periodically changing the volume of the pump chamber, the positive displacement pump transmits the energy to the conveyed liquid with the periodic change of action and displacement, so that the pressure can be directly increased to the required pressure value to realize the transportation.

Such as: 1) reciprocating pump, including piston pump, plunger pump, diaphragm pump, extrusion pump, etc;

2) Rotor pump, including gear pump, screw pump, roots pump, rotary piston pump, sliding vane pump, crankshaft pump, flexible rotor pump, peristaltic pump, etc.

38. What are the main performance parameters of the pump?

Mainly includes: flow, head, NPSH, speed, power and efficiency.

39. Why should the standby equipment be turned manually and regularly? What shall be noted when turning ?

1) Regularly turn the standby equipment, to check whether the equipment operates flexibly and free of blockage, and to prevent the bearing from bending and deformation, so the equipment really plays a standby role.

2) Matters needing attention during turning: before turning, oil should be added to the pump for oil rejection lubrication, in order to prevent damage to the bearing; after turning, the stop position of the rotor is an angle of 180 degrees to the original position.

40. What is the harm of excessive current to pump?

Rated current refers to the current that the motor normally works at the rated voltage and rated power. If more than the rated current, the motor is easy to overheat, the relay protection device acts and then the pump stops. And if the relay protection device does not act or acts poorly, the motor may be burn, and the pump may be damaged.

41. What are the main contents of the pump inspection?

1) Check whether the indicated values of pressure gauge and ammeter are within the specified range and remain stable;

2) Check whether the operating sound is normal and free of noise;

3) Whether the temperature of bearing and motor is normal (no higher than 60 °C);

4) Check whether the cooling water is unblocked, whether the packing pump and mechanical seal leak, if yes, whether the leakage is within the allowable range;

5) Check whether the connection parts are tight, and whether the anchor bolts are loose;

6) Check whether the lubrication is in good condition and the oil level is normal;

42. When the maintenance personnel come to post for maintenance, what should the operators do?

1) Check whether the maintenance work ticket is consistent with the actual position number of equipment to be repaired;

2) Contact the monitor on duty to call the electrician in the area to cut off the power;

- 3) Provide the damaged condition and the specific parts to be repaired to the maintenance personnel;
- 4) Cooperate with maintenance on site and supervise the maintenance quality;
- 5) After maintenance, call for power supply and test run;
- 6) After normal operation, report to the monitor on duty and make the records at the same time.

43. What is the function of inlet and outlet valves of pumps?

- 1) The inlet valve is a component that isolates or cuts off the pump from the system during maintenance. It cannot be used for adjusting the flow rate, and should be fully open;
- 2) The outlet valve is a component regulating the flow rate and isolating and cutting off the pump from the system during startup and shutdown maintenance.

44. What is the basis for selection of seal of pumps used in chemical production?

It is selected according to process conditions, working pressure, medium corrosion and rotation speed.

45. How many types of flat gasket seals?

1) Non-metallic gasket seal; 2) Non-metallic and metal composite gasket seal; 3) Metal gasket seal.

46. What are the main causes of gasket leakage?

- 1) Leakage caused by design: a. Improper selection of flange and flange sealing surface; b. Improper selection of gasket; c. Improper selection of material of flange and bolt;
- 2) Leakage caused by manufacturing, installation and operation: a. The machining accuracy of flange and gasket has not reached the technical requirements; b. Improper operation during bolt tightening results in offset of gasket; c. The sealing face of flange is not clean and there are impurities.

47. What is a mechanical seal?

Mechanical seal is also called as end face seal, it is composed of at least one pair of end faces perpendicular to the axis of rotation. Under the action of fluid pressure and compensation mechanism, the two end faces closely fit and slip relative to each other to prevent fluid leakage.

48. How many types of seal used for pumps commonly?

There are two types, dynamic seal and static seal.

49. What are the main causes of mechanical seal leakage?

1) There is excessive wear on the sealing face between the moving ring and the static ring, and the load coefficient is unreasonable in the design, resulting in cracks, deformation and damage on the sealing face.

2) Several auxiliary sealing rings have defects or defects caused by improper assembly, and the auxiliary sealing ring selected is not suitable for the working condition and working medium.

3) The pretension of spring is insufficient or the spring is broken, corroded, loosen, coked after long-term operation, or the suspended particles or crystals of the working medium accumulate and blocked in the gap of spring gap for a long time, resulting in spring failure, the compensation seal ring unable to float, and leading to leakage;

4) Because the perpendicularity deviation between the seal face of dynamic and static ring and the center line of shaft is too large, the seal faces are not tightly bonded which results in leakage;

5) if the axial displacement of the shaft is large, and the coordination or quality of accessories related to the seal is poor, leakage is easy to occur.

50. What basis is the material of friction pair of mechanical seal selected?

It should be selected according to the nature of the medium, working pressure, temperature, sliding speed and etc. Sometimes, the ability to withstand short-time dry friction in case of startup or liquid film failure shall be considered.

51. What are the effective ways to increase medium resistance of labyrinth seal?

1) Reduce the gap, 2) Strengthen the vortex, 3) Increase the number of sealing teeth, 4) Try to convert the kinetic energy of the airflow into heat energy

52. What is the working principle of floating ring seal?

The floating ring seal achieves the purpose of sealing the gas, based on the throttling effect generated by the narrow gap between the shaft and the floating ring, and the sealing oil of higher pressure than the gas injected into the gap.

53. What is the cause of the increased leakage of the floating ring seal?

- 1) After a long-term use, the gap is created because of normal wear.
- 2) The surface of the bushing of the floating ring hole is rough, the accuracy is low, and the gap increases because of short-term wear ;
- 3) Deflection caused by improper assembly, the centering accessories falls, and the oil flows out of the other gaps, and then the leakage is increased.

54. What is the function of oil baffle? How to measure and adjust the clearance of oil baffle?

- 1) The oil baffle is used to prevent the lubricating oil of the bearing from flowing to the outside along the journal. There are two installation positions of the oil baffle: on the bearing seat, and on the bearing bush;
- 2) The oil baffle clearance can be measured with a measuring ruler when the oil baffle is disassembled or assembled. The oil baffle clearance on the bearing bush can be loosen up appropriately. The requirements of the oil baffle clearance on the bearing seat are relatively strict, generally, it is required to be 0.05-0.10mm at the lower part, 0.10-0.20mm at both sides, and 0.20-0.25mm at the upper part.

55. What are the factors affecting labyrinth seal?

- 1) The radial clearance is too large, or the clearance of the replacement gas seal ring is too small;
- 2) The sealing plate or gas seal ring and teeth become rusty due to wear, or deformed after heated due to long-term wear, resulting in damage and can not be used;
- 3) After long-term use, the spring becomes loose and deformed, so that the air seal ring cannot be placed in place. After operation, the dust and dirt deposit and accumulate, so that the pressure of the sealed medium is lower than the pressure of the working medium, or the pressure is unstable.

56. What are the common types of dynamic seals?

Cup seal, expansion ring seal, spiral seal, pneumatic seal, hydraulic seal, centrifugal seal, packing seal, labyrinth seal, mechanical seal, etc.

57. What are the main factors affecting sealing?

- 1) quality of seal, 2) process operation conditions, 3) accuracy of assembly and installation, 4) host accuracy, 5) auxiliary system of seal

58. What are the components of the mechanical seal?

The mechanical seal is composed of a static ring, a moving ring, a compensation buffer mechanism, an auxiliary seal ring and a transmission mechanism. The end faces of the static ring and the moving ring are perpendicular to the axis of the pump and fit each other to form a rotating sealing surface. The static ring and gland, the moving ring and the shaft are sealed with auxiliary sealing rings, and the sealing ring is pushed along with the axial direction under the action of the compensation buffer mechanism, to compensate for the effect of the buffer mechanism to push the sealing ring to move along the axial direction, keep the end face of the moving ring and the static ring stucked each other, and compensate the wear on the end face of the sealing ring.

59. What are the features of mechanical seals?

- 1) Good sealing performance, the leakage of mechanical seal is generally 0.01-5ml/h, and could be 0.01ml/h or even less according to special requirements and special design, while the leakage of packing seal is 3-80ml/h (according to the relevant regulations in China, it is no more than 3ml/h when the shaft diameter is not greater than $\Phi 50\text{mm}$, and it is no more than less than 5ml/h when the shaft diameter is $\Phi 50\text{mm}$);
- 2) Long service life, more than 8000h generally;
- 3) smaller friction power, only 20% - 30% of that of packing seal;
- 4) There is no relative movement between the shaft and the shaft sleeve and the seal, no friction occurs, and longer service life of the shaft and the shaft sleeve;
- 5) The sealing surface of the mechanical seal is perpendicular to the pump axis, and the seal moves whenever the pump shaft vibrates, so it can still maintain good sealing performance when the vibration is within a certain range;
- 6) The mechanical seal relies, keep the sealing surfaces of the static and moving rings fit under action of the spring force and the pressure of the sealing liquid, compensate for the abrasion loss amount of wear depending on the spring force. Therefore, once the pump is properly configured, it is no need to be adjusted frequently during operation, convenient to use and little maintenance;
- 7) wide range of working conditions, it could be used under condition of high temperature, low temperature, high pressure, high speed and strong corrosion;
- 8) Troubleshooting and replacement of parts are inconvenient, and maintenance can only be carried out after shutdown;
- 9) Complicated structure and high assembly accuracy, a certain technical requirements are necessary for assembly and installation;
- 10) High manufacturing cost.

60. What are the main characteristic parameters of mechanical seals?

1) Shaft diameter: the range of shaft diameter of pump mechanical seal is generally 6-200mm, especially 400mm. The shaft diameter of pump is usually determined according to the strength requirements, rounded or modulated with shaft sleeve to meet the standard shaft diameter of mechanical seal;

2) Rotation speed: it is generally same with the pump speed, the speed of centrifugal pumps is less than or equal to 3000r/min generally; the high-speed centrifugal pumps is less than or equal to 8000r/min, and special pumps is less than or equal to 4000r/min;

3) Average peripheral velocity of the sealing surface: refers to the peripheral velocity of the average diameter of the sealing end face. The average linear velocity of the sealing surface causes greater heat and wear on the sealing surface (friction pair). Generally, the peripheral velocity of the loading and unloading seal is less than or equal to 30m/s; the peripheral velocity of the spring static mechanical seal is less than or equal to 100m/s; in special cases, it can be less than or equal to 150m/s;

4) Face specific pressure: the face specific pressure P_c is the contact pressure borne by the sealing surface (MPa). The face specific pressure of the end face seal should be controlled within a reasonable range, the seal performance would be affected if it was too small, and the seal face would be heated and worn if it was too large. The reasonable face specific pressure of the mechanical seal for pump use: built-type mechanical seal, $P_c = 0.3-0.6\text{mpa}$ generally; External type, $P_c = 0.15-0.4\text{mpa}$. And the face specific pressure could be increased appropriately when the lubricity is good, in case with the liquid with larger viscosity, the face specific pressure can be increased, can be $P_c = 0.5-0.7\text{mpa}$, and in case of liquid which is volatile and poor lubricity, the face specific pressure should be smaller, can be $P_c = 0.3-0.45\text{mpa}$.

61. What are the inspection contents before mechanical seal assembly?

1) General inspection: the model, specification, performance, fit size of each components and whether there was any damage such as notch, pit, deformation or crack.

2) Inspection of moving and static rings: the sealing end face should be bright and clean without defects such as edge collapse, pits, grooves or scratches. In case of a graphite ring, it should be dipped to be checked if there is any cracks.

62. How to check the parallelism, perpendicularity and surface roughness of the end face?

1) Flatness of end face: 0.0006-0.0009mm for liquid medium and 0.0001-

0.0004mm for gas medium;

2) Tolerance of balance: the parallelism deviation between the sealing end face and the contact surface of the sealing ring is generally less than or equal to 0.04mm. The parallelism deviation of both ends of the insert ring (ceramic ring and cemented carbide ring) should be less than or equal to 0.03mm;

3) Tolerance of perpendicularity: For the perpendicularity deviation of the end face against the outer diameter center line facing the sealing ring installed, the full diameter should be less than or equal to 0.03mm;

4) Surface roughness: hard material of the sealing surface (obtained by removing material), dark glossy surface (obtained by grinding), soft material (obtained by removing material), no visible machining traces, and the micro machining direction (obtained by grinding, fine turning), the contact point with the auxiliary sealing ring (obtained by removing material), no visible machining traces, the micro machining direction (obtained by grinding, fine turning), and the rest (obtained by removing material), slight tool marks (obtained by knife twisting and fine turning).

63. What are the requirements on the inspection of auxiliary seal ring of mechanical seal?

1) The surface of the auxiliary sealing ring is smooth and flat, and no defects such as bubbles, cracks, gaps, etc is allowed.; the size of end face size should be uniform; the burr of the "o"-shaped sealing ring should preferably form a 45- degree angle with the working surface;

2) The hardness of the auxiliary sealing ring should be selected according to the pressure, the hardness should be higher if the sealing pressure is higher, and vice versa. Synthetic rubber is adopted for auxiliary seals commonly;

3) for "o"-shaped sealing ring on the sealing cylinder, the inner diameter should be 0.5-1mm smaller than the outer diameter of the sealing point. The inner diameter of the "o"-shaped sealing ring of the moving ring is small, and the inner diameter of the "o"-shaped sealing ring of the static ring is smaller than that of the static ring;

4) The compression amount of the auxiliary seal should be appropriate. If the compression amount is too large, the sealing effect is good, but the friction resistance is large, difficult to be assembled, and the swimming compensation ability is poor during operation. If the compression is too small, the friction resistance is small, easy to be assembled, but the sealing effect is poor. The "o"-shaped rings of the static and dynamic rings of the mechanical seal are all cylindrical seals, and their compression is about 8%-23% of the diameter of the cross-sectional surface. If the diameter is small, take a larger

percentage; if the diameter is large, take a smaller percentage.

5) Other functions should be considered for the compression of the "o" ring. For example, for the static ring without anti rotation pin, the static ring "o" ring plays a dual role of sealing and anti rotation, and the compression of the "o" ring should be larger to avoid the rotation of the static ring and seal failure. On the premise of ensuring the sealing effect, the compression amount of the "o" shaped sealing ring of the dynamic ring should be smaller, otherwise no floating compensation due to too large compression and too large resistance.

64. What is included in the inspection of mechanical seal spring?

Spring inspection includes: total number of coils, effective number of coils, free height, whether the axis is perpendicular to the end face, and spring rotation direction. If a single spring, the rotation direction must be checked, if a mutiple spring, the rotation direction does not need to be checked.

A new spring, the original free height should be checked, and the free height should be measured and compared with the original records. If the residual deformation is too large, it shall be replaced. And a old spring, the elasticity needs to be measured after cleaning, and it needs to be replaced if the elasticity decreases by 20%.

For multiple spring mechanical seal, the difference of free height of each spring should not be less than 0.5mm.

65. What are the requirements of the inspection of shaft and shaft sleeve before the installation of mechanical seal?

1) Check the fit size of the shaft (or shaft sleeve), surface roughness, chamfer, axial displacement and radial runout of the shaft. If there is a shaft sleeve, check the fit clearance between the shaft and the shaft sleeve. The surface roughness of the installed mechanical seal shaft diameter (or shaft sleeve) should be less than 1.6, and the axial displacement of the shaft should not be greater than 0.25mm. The shaft sleeve is not allowed to move axially, and the radial runout of the shaft or shaft sleeve is allowed.

2) Check the abrasion of the shaft and shaft sleeve. Because of the mechanical vibration and the compensation floating of the moving ring, the shaft and shaft sleeve may also be worn by the "o" seal ring. If they are worn, they should be flattened, polished or replaced;

3) The shaft sleeve seat and shaft sleeve should be intact.

66. What are the inspection contents of seal face or sea box?

The roughness of the surface contacting with the static ring seal ring is 1.6, and the end circular run-out should be no greater than 0.06mm after the static ring is assembled. The seal end face or seal cavity should be free of burrs, and the chamfer radius should be sufficient and smooth. The inner diameter of seal face or seal cavity should meet the requirements.

67. What are the "six fixed" contents of tour inspection of pumps?

The inspection should be carried out with fixed route, fixed person, fixed time, fixed point, fixed responsibility, and fixed requirements.

68. How many types of overhaul of chemical pump generally?

There are three main types: 1) maintenance overhaul, 2) unplanned overhaul, and 3) planned overhaul.

69. Precautions for assembling auxiliary sealing ring?

1) The rubber auxiliary sealing ring could not be soaked or washed with gasoline and kerosene, to avoid swelling, deformation and premature aging; 2) The "o"-shaped sealing ring installed on the static ring assembly, should be smooth and not twisted, on a cross section when the burr is in a free state; 3) When pushing the assembly, prevent damage to the "o" ring. The main damage forms are: falling block, crack, bruise, crimping and twisting.

70. What are the causes of crack on "o"-shaped ring of mechanical seal?

The shaft surface is rough or has burrs; the old shaft or sleeve is damaged by the fastening screw, and is not polished before assembly; the edges of the keyway and anti-rotation pin groove are not properly fixed.

71. What are the requirements of spring compression debugging of mechanical seal?

Compression amount of spring, is the amount of the mechanical seal spring compressed by a drive screw. After the mechanical seal is installed completely, it is compressed by another amount against the spring, the amount is called mechanical seal compression. The total compression of the mechanical seal spring is the sum of the compression of the drive screw and the elastic force of the spring itself. During assembly, the greater the compression of the mechanical seal, the smaller the force of the spring on the dynamic ring. Therefore, the size of the spring has a great influence on the

performance and service life of the mechanical seal based on the working principle of the mechanical seal. So the compression must be adjusted according to the technical requirements during assembly.

72. What shall be noted when installing static ring assembly?

1) Insert the inspected static ring seal ring from the tail of the static ring, and put the static ring assembly into the gland or seal cavity. Under no circumstances, impact force is not allowed to be applied on mechanical seal parts or components. The pressed surface should be padded with clean cardboard or cloth to avoid damage the seal face.

2) After the rotating dynamic ring assembly or static ring assembly is assembled, press the compensation ring with hands to check whether it is installed in place and is flexible; Whether the elastic opening is positioned reliably.

3) Whether the perpendicularity between the seal face and the center line of the shaft or shaft sleeve meets the requirements.

4) For the static mechanical seal, the anti-rotation pin lead of the static ring assembly should be accurate. When the static ring assembly is pushed in, the pin groove of the assembly should be aligned with the pin. After pushed in place, measure the distance from the end face of the assembly to an end face of the sealing cavity to check whether it is installed in place;

5) When tightening the bolts to compress the end cover, the strength should be uniform and symmetrical, and shall be tightened in several times, and can not be tightened in one time to avoid deviation or even crushing the graphite ring.

73. What are the requirements on inspection after mechanical seal assembly?

After assembly, the mechanical seal should be inspected twice.

1) Turning inspection. Since there was only a small amount of lubricating oil on the sealing face of the moving and static ring as no liquor is filled, more turning is not suitable to avoid damage to the sealing face.

2) Liquid filling inspection. Check whether there is leakage, and test run is allowed if there is no leakage.

74. What is the inspection standard for leakage point of dynamic seal?

1) The packing sealing point should be no more than 15 drops per minute;

2) The mechanical sealing point is not allowed to leak at the initial stage, and no more than 15 drops per minute at the final stage;

3) The gear oil pump allows slight leakage, no more than 1 drop per minute;

- 4) All kinds of oiler allow micro-leakage, not more than 1 drop per minute.

75. What are the requirements when fill packing into the packing flange?

- 1) the packing
- 2) The packing should not be pressed too tightly. The gland bolts should be symmetrically closed and pressed evenly. The depth of pressed gland is generally the height of one circle of packing, and not less than 5mm.

76. What preparations should be made before mechanical installation of packing?

- 1) The selection of packing: shall select according to the form of packing and the pressure, temperature and corrosion resistance of the medium, the medium, form, size and performance of the packing should meet the requirements and standards of the equipment;
- 2) Before packing installation, the packing box should be cleaned, inspected and repaired, and the damaged parts should be replaced;
- 3) Check the fit clearance among the shaft, the gland and the packing.

77. How many types of lubrication?

- 1) Dripping oil lubrication, 2) Oil mist lubrication, 3) Splash lubrication, 4) Pressure lubrication, 5) Dry oil cup lubrication;

78. What factors should be considered for selecting lubricating oil?

- 1) Movement velocity, 2) Movement property, 3) Operating temperature, 4) Pressure relationship, 5) fitting property of friction surface, 6) Surface roughness

79. What are the function of lubricant?

- 1) Cooling, 2) Anti-rust, 3) Cooling, 4) Flushing, 5) Friction control, 6) Wear reduction, 7) Vibration reduction, 8) Sealing;

80. Where are the occasion applicable of calcium base grease, sodium base grease and lithium base grease?

- 1) Calcium base grease: water resistant, can be applied in moisture workplaces, but not high temperature resistant, the temperature range of use is -10 ~ 60 celsius degree;
- 2) Sodium base grease: high temperature resistant, but not water resistant, the temperature range of use is -10 ~ 110 celsius degree;
- 3) Lithium base grease: heat resistance and water resistance, the temperature range

of use is -20 ~ 1200 celsius degree;

81. What are the "five fixed" of pump lubricant management?

The pump should be checked and lubricated: in fixed point, at fixed time, with fixed quality, with fixed quantity and with fixed person, to ensure normal operation of the pump;

82. What is the basic principle of the importance of lubrication to pumps?

The lubricant can be firmly attached to the friction surface of the machine part to form an oil film. The oil film is strongly combined with the friction surface of the machine part, the two lubrication surfaces are separated by the lubricant, to change the friction of the machine part to the friction of lubricant molecules, so as to reduce friction and wear and prolong the service life of the machine part.

83. What are the causes of oil leakage of oil lubricated pump?

1) The oil level is too high, oil leaks along the inner holes of the bearing caps at both ends of the bearing box; 2) oil leakage at the static sealing points, eg. the draining oil screw is blocked; 3) Oil leakage on the joint surface of bearing gland and bearing;

84. How does the lubricant play during the rotation of the bearing?

1) Lubrication, 2) Cooling, 3) Washing, 4) Anti-rust, 5) Sealing, 6) Cushioning and damping, 7) Anti-friction and wear;

85. What are the main properties of lubricant?

Acid value, viscosity, viscosity index, flash point, mechanical impurities, freezing point, residual carbon and ash content.

86. How many methods are there to measure the clearance of journal bearings?

How to measure with use the shaft lifting method?

There are three common methods: checking with lead, shaft lifting method, and pseudoaxis method.

Shaft lifting method: install a dial indicator at the position w close to the bearing bush, and then install a dial indicator on the top of the upper shell of the bearing bush for monitoring. Gently lift the shaft diameter until it touched the upper bush, and the upper bush shell didnot move too much. At this time, the bearing bush clearance can be is the reading of the dial indicator on the shaft diameter minus the amount of movement of the

upper bush shell.

87. What are the faults of journal bearing? How to troubleshoot faults ?

Fault: gluing.

Treatment measures: 1) ensure the installation position and clearance are correct, 2) ensure good lubrication of rotor.

Fault: fracture by fatigue.

Treatment measures: 1) the bearing surface should be smooth, 2) ensure good balance of the rotor.

Fault: wear.

Treatment measures: 1) avoid insufficient lubrication, 2) clean the lubrication system in time.

Fault: scratch.

Treatment measures: 1) prevent instant cut-off of oil, 2) avoid collision during installation or disassembly.

Fault: galling.

Treatment measures: clean the oil circuit to prevent dirt from entering.

Fault: cavitation.

Treatment measures: 1) increase the oil supply pressure, 2) modify the shape of oil groove and oil groove of the bearing bush, 3) reduce the bearing clearance.

Fault: electric erosion.

Treatment measures: 1) ensure that the insulation condition and protective device of the machine are in good condition, 2) ensure that the machine is well grounded; 3) Check the shaft diameter. If there are electric corrosion pits on the shaft diameter, polish the shaft diameter to remove the pits.

88. What are the reasons of the gluing of sliding bearings in use?

1) Bearing overheating, 2) excessive load, 3) insufficient oil, 4) improper operation or temperature control failure.

89. What are the causes of the abnormal sound of rolling bearing during operation?

- 1) The rolling element or raceway is seriously stripped, and the surface is uneven.
- 2) Improper installation of bearing accessories, looseness or friction.
- 3) There is scrap iron or dirt in the bearing.
- 4) Lack of lubricant.

90. What are the radial clearances of rolling bearing?

- 1) Original clearance: the clearance of bearing in free state before installation.
- 2) Fit clearance: the clearance after the bearing is installed on the shaft or in the hole, the size is determined by the magnitude of interference. And the fit clearance is smaller than the original clearance.
- 3) Working clearance: due to the structural characteristics of some bearings, the clearance can be determined by adjusting the mutual positions of bearing rings during assembly or use, such as the radial-thrust ball bearings.

91. What should be paid attention to when selecting rolling bearings?

- 1) The direction and property of the load.
- 2) Requirement of self-aligning performance.
- 3) Bearing speed.
- 4) Economy.
- 5) Accuracy.

92. How to choose the lubrication mode of rolling bearing?

The normal operation of the bearing is related to lubrication. When the conveyed medium is at 80 celsius degree and the rotation speed is below 2950r/min, dry oil lubrication is adopted; when the conveyed medium exceeds 80 celsius degree and the power is higher, thin oil lubrication is adopted.

93. How to check the quality of rolling bearing?

The surface of rolling element and raceway should be free of spots, holes, dents and peeling. The bearing shall rotate flexibly, after being turned by hand, it shall decelerate and stop smoothly and gradually, shall not stop suddenly, and vibration is not allowed. There should be a certain clearance between the holder and the inner and outer rings. The isolation frame can be pushed radially by hand for experiment. The clearance should be within the standard range and measured by lead pressing method.

94. What shall be noted to when disassembling rolling bearings?

- 1) The force applying part shall be correct, The principle is the inner ring shall be applied with the shaft and the outer ring applied with the outer shell, to avoid deformation or gouges of the rolling element and raceway.
- 2) The force shall be applied symmetrically, cannot hit only one side, otherwise, the bearing may get deflected and the journal may get damaged.

3) Before disassembly and assembly, the shaft and bearing shall be cleaned, shall be free of rust, burr and etc.

95. What would happen if there is too much oil in the bearing box?

There would be no heat dissipation space in case the bearing box is filled with too much oil, which will cause the bearing heating.

96. Why should the rolling bearing be preloaded?

When assembling the radial-thrust ball bearing or radial ball bearing, if a certain axial load is applied to the inner and outer rings of the bearing, there would be relative displacement between the inner and outer rings, and the clearance between the inner and outer rings and the rolling element would be eliminated, and initial elastic deformation would be caused. Preloading can improve the rotation accuracy and service life of the bearing, and reduce the vibration of the shaft.

97. How to realize preloading of rolling bearing?

1) Preloading is realized by the thickness difference between the inner and outer backing rings of the bearing.

2) A spring is used to realize the preloading, and the bearing is preloaded by the spring forces on the outer ring of the bearing.

3) Narrow the inner ring or outer ring used in pairs to realize preloading.

4) Adjust the axial position of the inner ring of the taper hole of the bearing to realize preloading.

98. What is the substitution principle of rolling bearing?

1) The technical parameters including working capacity coefficient, allowable static load and etc of the bearing should be equal to or higher than the original bearing as far as possible.

2) The allowable limit speed of the substitute bearing selected should be equal to or higher than the actual speed of the original one.

3) The accuracy grade of the substitute bearing should not be lower than that of the original one.

4) The size of the substitute bearing should be the same with the original one, and the size of the machine matching with the bearing can not be changed at will because of the replacement of the bearings.

5) For the bearing with nesting method, the concentricity of the nested inner and

outer cylinder should be ensured, and the tolerance and fit should be correctly selected.

99. How many fixing type of rolling bearings?

1) Unilateral stressed and bidirectional fixed; 2) Bilateral stressed and unidirectional fixed; 3) mixed fixing

100. What is the basis for determining the oil level of the bearing?

For rolling bearings, the center line of lowest bead of the bearing is the normal oil level, the lower one third of the beam is the low oil level, and the upper two thirds above the center line of the beam is the high oil level.

For the lubrication device of which the main shaft is an oil slinger, the diameter of the oil ring is generally 1.5-2 times larger than that of the main shaft lubricated. There shall be a certain distance between the oil level in the oil chamber and the main shaft oil, which is generally one-second of the diameter of the main shaft or the high oil level about 5mm below the bearing bush.

101. Why either too high or too low oil level of bearing oil is bad?

1) If the oil level of the bearing is too low, some parts of the bearing cannot be lubricated, so the bearing will be worn and heated, and then burned.

2) If the oil level is too high, with the rotation of the main shaft, the oil is leaked easily from the shaft seal during the oil carrying over process of rolling bearing and the oil ring; if the oil level is too high, the rotation of the oil ring will be hindered, which causes the bearing heating.

102. What are the requirements for oil filling of bearings lubricated with grease?

1) For machinery with lower rotating speed (below 1500r/min), the oil filling amount is generally not more than two-thirds of the whole bearing chamber; 2) For machinery with rotating speed above 1500r/min, the oil filling amount should not be more than one-second of the whole bearing chamber.

103. What are the causes for the high temperature of the bearing?

- 1) The oil level is too low and the amount of oil entering the bearing is reduced.
- 2) Unqualified oil, mixed with water or impurities, the oil is emulsified and went bad;
- 3) The oil ring does not rotate and the oil supply of the bearing is interrupted.
- 4) Insufficient cooling water supply of the bearing

5) Bearing is damaged

6) The tightening force exerted by the bearing gland on the bearing is too large or too small, or the radial clearance is crushed, and the bearing becomes less flexible.

104. What are the requirements on the performance of bushing material of the sliding bearing?

1) It should have enough strength and plasticity, bearing lining can not only bear a certain working pressure, but also can be evenly distributed with the pressure between the journal.

2) Good foaming property and wear resistance.

3) Good lubrication and heat dissipation performance.

4) Good process performance.

105. What material shall be used for making the sliding bearing shell?

Cast steel, forged steel, and cast iron

106. According to experience, what is the radial clearance of bearing shell generally?

The radial clearance can be one-thousandth to three-thousandths of the shaft diameter according to different structural form of bearings.

107. What is the effect of the size of the sliding bearing clearance?

1) smaller clearance, higher accuracy. But if the clearance is too small, the lubrication cannot be guaranteed and the oil film cannot be formed.

2) larger clearance, lower accuracy, pulsation easily happen during operation, and the oil film is unstable.

108. What are the advantages of tilting pad bearings?

The advantage of tilting pad bearing is that each pad can swing freely, the optimum oil film can be formed in any case, oil film oscillation not easily happen.

109. What is unqualified bearing?

1) original rotation accuracy is lost 2) Noise during operation, 3) Large rotating resistance.

110. What are the causes of overheating of rolling bearing of centrifugal pump?

1) The reserved axial clearance of rolling bearing is small

- 2) Incorrect installation direction
- 3) Dry wear or looseness
- 4) Poor lubricating oil quality, insufficient amount of oil or poor circulation
- 5) The oil slinger is deformed and cannot be oiled.

111. What is the waste standard for rolling bearing for pumps (radial ball bearings)?

- 1) The raceways of the inner and outer rings are peeled off, severely worn or cracked.
- 2) The rolling element is out of round or the surface is peeled off with cracks.
- 3) The holder is severely worn or deformed, and the rolling element cannot be fixed.
- 4) There is noise or vibration during rotating, braking and reverse rotation happen when stop.
- 5) The fit clearance of the bearing exceeds the maximum specified clearance.

112. What is the cause of the scale-like peeling phenomenon on the raceway surface of the bearing inner ring and outer ring or the rolling surface of the rolling element?

1) Excessive load, 2) poor installation, 3) infiltration of foreign matters, unsuitable lubricant, 4) inappropriate bearing clearance, 5) poor accuracy of shaft and bearing housing, uneven rigidity of bearing housing, large deflection of shaft, 6) rust, erosion point, scratch and indentation.

113. What are the properties of bearing metal?

1) Low friction coefficient to reduce wear and tear of bearing; 2) High plasticity makes the bearing and bearing bush run in well; 3) Good thermal conductivity; 4) Sufficient compressive strength and fatigue strength.

114. What are the properties of high-speed sliding bearing?

1) Be able to bear radial and axial loads; 2) Small friction coefficient; 3) Long service life, and stable and reliable operation at high speed.

115. What are the causes of rolling bearing vibration?

1) Random vibration transmitted by rolling element. 2) Random vibration generated due to improper installation and lubrication. 3) Vibration from outside of the bearing.

116 . What are the requirements of assembling for rolling bearings?

- 1) The end face marked with the model of the bearing shall be visible, for easy replacement.
- 2) The arc radius of the shoulder hole of shell or of the journal should be smaller than the arc chamfer radius of the bearing end surface, to ensure that the bearing is tightly attached to the shaft shoulder and shoulder hole of the shell after assembly.
- 3) The fixing device of the bearing must be intact and reliable, with moderate tightening degree, flexible and reliable.
- 4) During the assembling procedure, keep clean and prevent sundries from entering the bearing;
- 5) After assembly, the bearing rotates flexibly, free of noise, and the temperature rise generally does not exceed 50 degrees.

117. What are the common materials of bushing of sliding bearings? And what are their characteristics?

- 1) Gray cast iron, is used under condition of low speed, light load and no impact load. HT15-33 and HT20-40 are commonly used.
- 2) Copper-base bearing alloy. ZQSn10-1 phosphor tin bronze and ZQA19-4 aluminum bronze are commonly used, which are suitable for working under condition of medium speed, high turbidity and impact load.
- 3) Oil bearing: it is generally a porous material, made of bronze, cast iron powder and an appropriate amount of graphite, pressed moulding and sintered at high temperature. It is often used under condition of low or medium speed, light load and inconvenience for lubrication.
- 4) Nylon: Nylon 6, nylon 66 and nylon 1010 are commonly used. Nylon bearings have the advantages of good saturation, free of damage to the journal after the wear and tear because of soft surface, and good corrosion resistance, and disadvantages of poor thermal conductivity and expansion after water absorption.
- 5) Bearing metal (Babbitt metal). It is the metal of tin, lead, copper, antimony and etc., which has good wear resistance, but poor strength. It cannot be made into a bearing bush alone, and is usually cast on a bearing bush substrate such as bronze, cast iron, and steel.
- 6) Three-layer load bearing material. There are two commonly used materials: Polypropylene fluoroethylene steel matrix composite material and polyoxymethylene steel matrix composite material.

118. What is the cause of excessive temperature rise of rolling bearing?

- 1) There are impurities or dirt intruding in during installation and operation.
- 2) Improper lubricant or insufficient lubricating oil is used.
- 3) Friction is caused by friction or loose fit among sealing devices, hot ring, and bushing etc.
- 4) Incorrect installation, such as deflection of inner and outer rings, inconcentricity of holes of mounting seat, deformation of raceway and improper adjustment of clearance.
- 5) Incorrect model of bearing is selected for substitution, will emit heat due to overload or high speed.

119. How to install the radial ball bearing on the shaft with hammering method?

Knock the bearing ring with a steel sleeve, copper sleeve or copper rod symmetrically, and into the specified position uniformly. It is forbidden to knock the outer ring of the bearing to avoid damage to the bearing. After installation, rotate the outer ring to check if it is flexible and free of blockage.

120. What are the common disassembling methods of rolling bearings?

Hammering method, pulling method, pushing method, hot disassembling method.

121. What shall be noted when disassembling the rolling bearing (bearing is on the shaft) with hammering method and pulling method?

1) The knocking force shall apply on the inner ring of the bearing generally, shall not apply on the rolling element and holder, and can not apply on the outer ring of the bearing.

2) in case of pulling method, the inner ring of the bearing should be pulled. If only the outer ring is pulled, the bearing would be loose too much or damaged.

122. How to adjust the clearance of split radial sliding bearing?

1) Adjust the gasket at the joint surface to make the top clearance and side clearance of the shaft and the bearing bush meet the requirements. In case there is no standard, the clearance could be within range of one-thousandth to two-thousandths of the journal based on experience and according to the rotating speed, load and lubrication conditions.

2) The side clearance is one-second of the top clearance generally.

3) If the gasket is not allowed to be added because of the structure, the clearance must be adjusted by repairing and grinding the tile edging of the upper bearing bush.

While adjusting the clearance of the tile edging, the lower and upper tile edgings shall fit

tightly, and could not exceed 0.05 mm.

123. What are the main types of damage of rolling bearing?

1) Fatigue pitting, 2) scratch, 3) burn, 4) electric corrosion, 5) damage of holder, 6) inner and outer ring breaks, 7) ball out of round, 8) surface of raceway stripped.

124. What are the features of key connection?

Key connection is that, the shaft parts are fixed circumferentially with the side transfer torque of the key, and can not bear axial force. If axial fixation is required, positioning parts such as fastening screws or positioning rings need to be added.

125. What are the assembly requirements of loose key connections?

For ordinary flat keys, woodruff keys and feather keys, some interference is necessary on both sides of the key after assembly, and a certain gap should be reserved on the top surface of the key, and the bottom surface of the key should be in contact with the bottom surface of the shaft groove. For the sliding key, the side key is in contact with the bottom surface of the wheel groove, and there is a gap between the key and the bottom surface of the shaft groove.

126. What are the configuration steps of loose key connection?

1) Clean the burrs on the key and key groove. 2) File the key, and there should be a gap of about 0.1mm between the key head and the shaft groove. 3) Fit the key head with the keyway, in case of ordinary flat keys, flat round keys and guidance keys, the keys can be tightly embedded in the shaft groove, and in case of sliding keys, it should be embedded in the wheel groove. 4) Add oil to the fitting surface, and install the key on the shaft with a copper rod or a hammer cushion.

127. Precautions for installation and disassembly of ordinary flat key and shaft groove?

Before installation, check and remove the burr and flash of the key groove, check the straightness of the key, and there should be a gap of 0.1mm between the key head and the key groove, add oil on the fitting surface and press the key into the key groove.

Before disassembly, knock the key lightly, shake it loose, and lift the key out from the key head side with a small flat spade or a screwdriver. It is strictly forbidden to hit or lift the key out from the fitting side of the key.

128. What are the requirements for the fitting between the key and the shaft?

1) There should be no problem on both sides of the key and key groove, and there should be a clearance of 0.1-0.4 mm on the top. 2) It is not allowed to increase the tightening force of the key by padding or twisting.

129. What are the four forms of deviation analysis of coupling alignment?

Concentric and parallel, concentric and non-parallel, parallel and decentraction, and decentraction and non-parallel.

130. What is one-point method measurement?

The method measuring the axial and radial clearances at a certain position of the coupling at the same point and same time, is called one-point measurement.

131. What is the principle of coupling alignment?

Coupling alignment mainly measures its radial displacement and angular displacement. When the two shafts are in different axes, there is a relative deviation between the outer rings or end faces of the two couplings. The deviation value of the axis line can be calculated according to the measured deviation value. In order to obtain correct measurement results, the two rotors must rotate at the same angle to ensure that the relative position of the measuring point on the coupling is variable, and the error caused by the non-smooth surface of the coupling and the non-vertical axis line of the end face can be eliminated in this way.

132. What is the precondition of alignment of the coupling?

- 1) The coupling overlaps the axis of the rotor.
- 2) The outer diameters of both the journal and the coupling are perfect circular.
- 3) The end face of the coupling is perpendicular to the axis.
- 4) Before alignment of the coupling, shall measure the radial runout and the rundout of the end face, and check whether the runout of the journal meets the requirements.

133. What are the requirements of coupling assembly?

Strictly ensure the coaxiality of the two axis to avoid no unilateral load during operation, so as to maintain balance and reduce vibration.

134. What are the methods of measuring radial displacement and angular

displacement in the alignment of coupling?

1) Measure with support and feeler gauge. 2) Measure with the center card and feeler gauge. 3) Measure with the center card and dial indicator.

135. What is the work principle of safety valve?

The safety valve is a valve that automatically opens and closes according to the working pressure of the medium. When the working pressure of the medium exceeds the specified value, the safety valve can automatically open the valve disc and discharge the excess medium (gas). When the pressure returns to normal, the valve disc can be automatically closed again.

136. What are the requirements of assembling of valves?

1) condition of assembling: After all components of the valve are cleaned, checked, repaired or replaced, the dimensional accuracy, mutual position accuracy, finish, material properties, heat treatment and other mechanical properties should meet the technical requirements before assembling.

2) principle of assembling: generally, the earlier disassembled part should be installed later, and the later disassembled part should be installed earlier. The coordination features shall be learned, sharp knock or disordered beat is forbidden. The operation should be carried out in order, from inside to outside, from bottom to top, from easy to difficult, and from parts, components, mechanisms to upper cover for pressure test.

3) Result of assembling: proper coordination, correct connection, complete installation, bolt on, flexible opening and closing, accurate indication, reliable sealing and adapt to working conditions.

137. What are the inspection methods of valve quality?

1) Visual inspection. 2) Dimension inspection. 3) Assembly inspection. 4) Disassembly inspection. 5) Pressure test inspection.

138. How many types of valves classified according to the structural feature?

1) Globe valve 2) Gate valve, 3) Plug valve, 4) Butterfly valve, 5) Swing valve, 6) Slide valve.

139. What are the basic parameters of the valve?

1) The nominal diameter of the valve, 2) the nominal pressure of the valve, 3) the

relationship between the working pressure and the working temperature of the valve, 4) the service medium of the valve.

140. What are the features and application of gate valves?

1) Advantages: better sealing performance than the globe valve, smaller fluid resistance, and less effort to open and close. When fully opened, the sealing surface is less eroded by the medium, and is not limited by the medium flow direction.

Bidirectional flow, smaller structural length, and wide application range.

2) Disadvantages: the overall dimension is high, requires a certain space for opening, longer opening and closing time, the sealing surface is easy to be eroded and scratched during opening and closing, and the two sealing pairs bring difficulties to processing and maintenance.

3) Application: gate valve is generally used for pipes and equipment with nozzles of diameter DN15-1800mm. It is mainly for cutting off, and is not allowed to be used for throttling.

141. What are the functions of valves?

1) Opening and closing, 2) regulating, 3) throttling

142. What shall be noted when installing the globe valve?

1) As the inlet and outlet of the globe valve are asymmetric, the medium should flow through the valve port from bottom to top during installation, that is, inlet from the lower and outlet from the higher, so that the valve can be opened with less effort and the packing is not easy to leak. It plays a role in cutting off and regulating pressure and flow.

2) If the globe valve is installed in the opposite direction, the inlet pressure would press the middle flange and packing part of the valve. Because the design pressure of the two parts of the valve is lower, leakage may happen at these two parts.

143. What are the general requirements of valve installation?

1) Before installation of the valve, the inside of the pipeline shall be cleaned to prevent the sealing surface of the valve from being scratched by iron oxide chips, welding slag, hard particles or other foreign matters. At the same time, carefully check the model and specification of the valve, and carefully check whether the valve can close tightly.

2) Pay attention to the installation direction of directional valves, and the valves shall not be installed backwards.

3) Because of left-right asymmetry of the valve chamber of the globe valve, the fluid flows through the valve ports from the bottom to top after installation.

4) Gate valves shall not be installed backwards either, otherwise the medium would reside in the valve chamber for a long time, and the valve stem can be easily corroded. The rising stem gate valves should not be installed down below, otherwise, the wheel column bar would be corroded.

5) There are two types of check valves: lift type and swing type. Lift type check valve can only be installed horizontally, and the swing type check valve should ensure that its shaft pin is installed horizontally. Swing check valves can be used in both horizontal and vertical pipelines.

6) Generally, valves should be installed in the closed state.

7) When installing or replacing heavy valves, the lifting lock should not be tied to the hand wheel or valve stem, but should be tied to the valve body, to avoid damaging the hand wheel or valve stem and other parts.

8) When the relief valve is installed, there should be both cut-off valves and pressure gauges both before and after it, and there should be a safety valve after it.

144. Which valves are direction selective?

Valves of direction selective: globe valve, throttle valve, relief valve and check valve.

145. How are the strength test process (hydrostatic test) of the valve?

1) Fill the valve with water to drain the internal air. 2) The valve is in open state. Slowly pressurize to the test pressure. 4) After reaching the test pressure, keep the pressure for more than 5min, and there should be no leakage at the packing gland of the valve body.

146. How should the safety valve be transported to the site for installation after calibration?

After the safety valve is calibrated, lead seal, and keep upright during transportation and installation, and collision with other objects is forbidden to ensure the calibration accuracy.

147. If a Z41H-25, DN80 gate valve with M16 bonnet and M12 bolt follower flange needs to be disassembled for maintenance and replacement of packing and bonnet gasket, what tools are required?

A 250-300mm adjustable wrench, a 24-27 plum wrench, a 17-19 plum wrench, an 8-inch screwdriver, a 1.5P hammer, and a flat scraper.

148. What test should be carried out for valve inspection?

Water pressure test for strength, and then the air tightness.

149. What does Z44B-16, DN150 mean?

Z-gate valve; 4-flange connection, 4-plane double ram; B-Babbitt alloy sealing mouth; 16-nominal pressure 1.6MPa; DN150-nominal diameter 150mm.

150. What does A41T-10 and DN100 mean?

A-safety valve; 4-flange connection; 1-angle type; T-sealing surface is copper mouth; 10-nominal pressure 1.0MPa; DN100-nominal diameter 100mm.

151. What is assembly? How many steps of the general assembly process?

In the production process, according to the provisions of drawings and technical requirements, the qualified parts are connected in various forms to form components, parts and finally form a complete machine, which is called assembly. The assembly process can generally be divided into component assembly, part assembly and general assembly.

152. How to divide the assembly work ?

For some large parts that need to be heated, and the matching parts are small, cold assembly is more suitable because of the limitation of the heating equipment. And there are some parts made of special materials or require good precision after assembly, and minimum deformation is allowed, cold assembly is must.

153. How is the assembly work divided?

1) Assembly of components, 2) Assembly of parts; 3) General assembly, 4) test run of final assembly.

154. What are the assembly methods for interference connectors?

- 1) Press-fitting method: hammering method and press-fitting method.
- 2) Thermal expansion matching method: install with heat, it is usually used for assembling interference connectors with the largest interference.
- 3) Cold shrinkage matching method: installed with cold, the characteristic is small

shrinkage, and is generally used for assembling interference connectors with small interference and limited by the method.

4) Hydraulic fitting method: hole expansion, used for Interference fit of shaft shrink assembly.

155. What is the lead of screw thread and the screw pitch? And What is their relationship?

Lead: It is the distance that one point on the thread moves along the axis when the point turns a circle along the helix.

Pitch: the axial distance between the corresponding points of two adjacent teeth.

Relationship: The lead of a single-head bolt is equal to the pitch, and the lead of a multi-head thread is equal to the product of the number of heads and the pitch.

156. Why should the threaded connection be protected against loosening? What are the commonly used methods?

Generally, the threaded connection can meet the condition of self-locking and cannot fall off automatically. However, the connection may be loosened itself under vibrating load and impulse load or large temperature change. In order to ensure reliable connection, anti-loosening should be considered in the design. The methods are: 1) anti-loosening by friction. 2) Mechanical anti-loosening. 3) Other anti-loosening methods, eg. pins, nails, pads, caps, etc.

157. What should be done in case of equipment accident ?

1) should find out the cause of the accident, 2) the person in charge and related person should draw lessons from the accident, 3) preventive measures should be taken. 4) The person in charge should be punished for the accident.

158. What is the content of the operator's four-know and three-can?

1) Four-know: know structure, performance, principle and application of equipment.

2) Three-can: can operate, maintain, and troubleshooting.

159. What is the "five-step" patrol inspection method of pumps?

The "five-step" patrol inspection method is listening, touching, measuring, watching and smelling.

160. What is the "five-step" maintenance method of chemical centrifugal pump?

The "five-step" maintenance method is cleaning, sorting out, lubrication, fastening and adjustment.

Note: This document is for reference only, and the Company shall not be liable for any errors, omissions, or misrepresentations or misrepresentations (whether express or implied). The Company shall not be obliged, responsible or liable for any loss, destruction or damage (including but not limited to consequential loss, destruction or damage) arising out of or in connection with the use or misuse of or reliance on the information contained in the Company.