MECHANICAL QUESTION&ANSWER

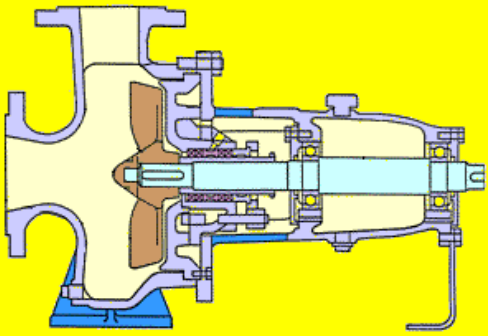
PUMPS

1. Name parts of the centrifugal pump?

Rotary parts; Shaft, Impeller, Coupling, Mechanical seal, Oil rings

Stationary parts; Casing, Stuffing box, Bearing housing

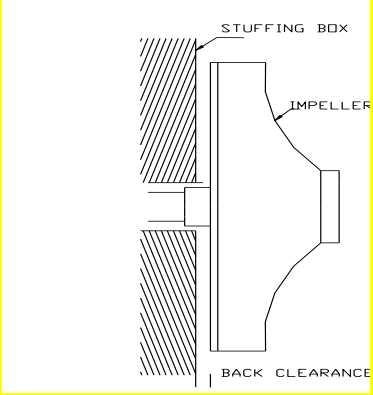
2. Explain overhauling steps for a back pullout pump?



Pump made: **PACIFIC** made: **HVC**

1. Remove coupling guards after getting clearance of safety aspects like electrical isolation, process lines drainage etc.
2. Remove coupling spacer and loose the casing bolts connects the stuffing box frame after removing and draining oil level glass and lube oil from bearing housing.
3. Pullouts back the pump from casing with care of casing gasket.
4. Dismantle all parts from the pump unit as impeller, mechanical seal assembly, shaft sleeve, coupling, and bearings respectively with high care.
5. The following factors should be checked and recorded for future to estimate the performance condition of the pump, are wear ring clearance, seal compression, shaft deflection, thrust, trueness etc while or after dismantle.
6. Proper tracing of parts need to any vision able damage like crack, score, break etc.
7. Best is changing new one comparing reconditioning of parts.
8. Assembly is the reversing procedure of dismantle as before seen.
9. Before coupled alignment should be checked and corrected

3. What is impeller back clearance?



The clearance between the backside of the impeller (shroud) and the stuffing box or crown (wear) plate.

Actually this clearance standardize the stuffing box pressure and should be strictly followed incase of depressurizing vanes on impeller and semi open impellers.

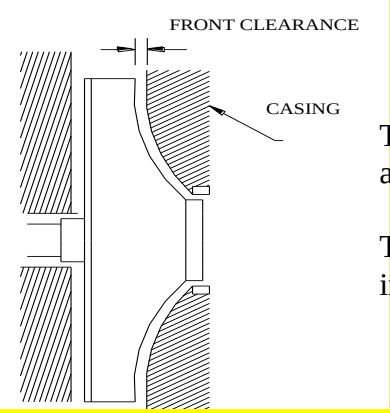
4.How do you check impeller back clearance?

By the use of feeler gauge and with dial indicator as possible.

5. How do you adjust impeller back clearance?

a. Add or remove shims behind the stuffing box.
b. Changing the position of the rotor depends clearance if possible.
c. Machining of impeller hub if there is no another way.

6. What is impeller front clearance?



The clearance between the front side of the impeller (crown) and the casing or wear plate

This clearance should be strictly followed incase of semi open impellers

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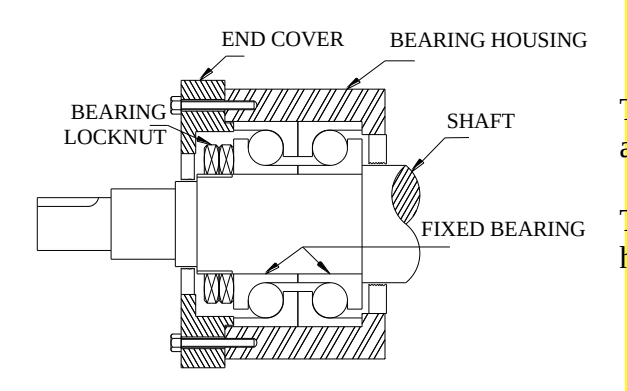
7. How do you check impeller front clearance?

By the use of feeler gauge and with dial indicator as possible

8. How do you adjust impeller front clearance?

Add or remove casing gasket thickness

9. What is fixed bearing?



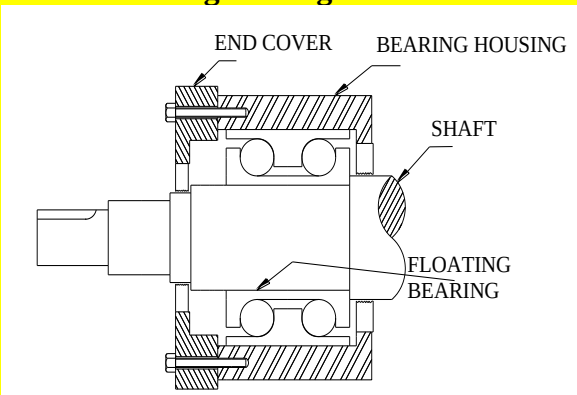
The bearing fixed with out any allowable axial clearance to permit thermal expansion.

This bearings bears the thrust load and only has thrust allowance of 0.001 – 0.003 inches

10. Where is fixed bearing located?

a. In back pullout pumps, fans – inboard
b. Double suction single discharge pump – outboard
c. Mixers (agitators) – top bearing

11. What is floating bearing?



The bearing fixed with allowable clearance to permit thermal expansion. And takes radial load normally.

12. Where is floating bearing located?

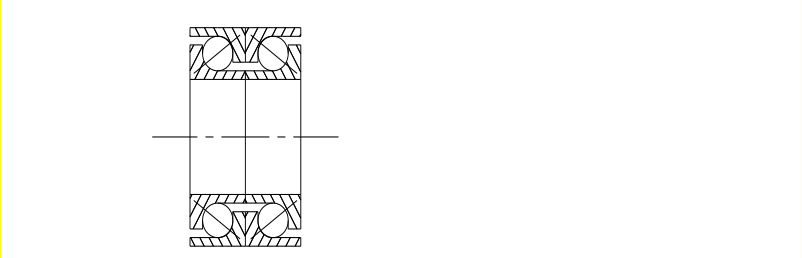
a. In back pullout pumps, fans – outboard

b. Double suction single discharge pump – inboard
c. Mixers (agitators) – bottom bearing

13. What is necessity of floating bearing?

1. Elongation due to thermal expansion of shaft
2. Axial fluctuation effects by load

14. What is bearing back-to-back arrangement?



15. Why bearing back-to-back arrangement is provided?

The back-to-back arrangement can support combined axial and radial loads and will keep the pump shaft end movement within acceptable limits. A bearing pair will support an axial load equally in either axial direction. It should preferably have a slight clearance (0 to 0.002 inches) with the bearing housing end cover.

16. In which series bearing back-to-back arrangement is available?

1. Single row angular contact ball bearing
2. Taper roller bearing.

17. How do you check plain journal bearing clearance?

i. By taking measurement difference between shaft outer and bearing inner diameters.
ii. By the use of plastic gauge or lead wire.

18. Is there any thumb rule for journal bearing clearance?

Bearing clearance necessary depends upon oil viscosity, speed and load.
0.001per 1 inch of journal diameter plus 0.0015 inches up to 9000 feet per minute journal velocity.
Above this speed 0.002 inches per 1 inch of journal diameter for shaft larger than 2.5 inches.

19. Have you seen tilting pad journal bearing?

Yes.

20. What is the advantage of tilting pad journal bearing over plain journal bearing?

Suitable for higher speeds and loads and has greater stability. It avoids the possibility of oil whirl and allows self-aligning.

21. How do you adjust tilting pad journal bearing clearance?

By add or remove shims behind the shoes of tilting pads.

22. How do you polish journal bearing?

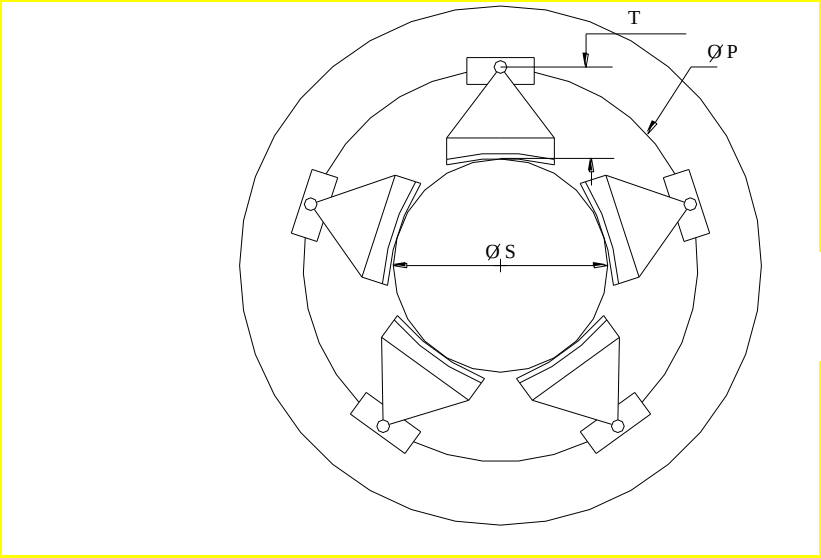
With the use of special polish oil (brasso) and 4/0 fine emery sheet or sponge pad. A special tool named as bearing scrapper used to clear deep able scratches.

23. What is spherical seated journal bearing?

The spherical seated journal bearing in which the shell of bearing in the form of spherical by which it allows self-accommodation on housing depends shaft aligns.

24. What are the various ways to check tilting pad journal bearing clearance?

a. By keeping dial indicator on shaft vertically besides bearing and lift the shaft to find out clearance of bearing through indicator reading.
b. By the use of mandrel as same diameter of shaft and moving bearing.
c. By manual measurement = diameter of pivot – (2 x thickness of individual pad) – diameter of the shaft.



BEARING DIAMETER
= Ø P - (2 x T) - Ø S

25. Give the 'go', 'no go' gauge dimensions for a 100 mm journal diameter with a minimum bearing clearance of 0.16 mm and maximum bearing clearance of 0.25 mm?

Go gauge dimension - 100.16 mm
No go gauge dimension- 100.26 mm.

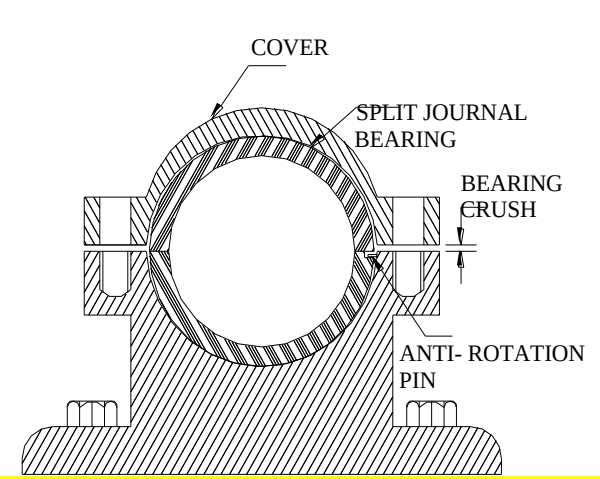
26. Why plastic gauge are preferred rather than lead wire?

a. Lead wire expands after removal from cap
b. It can be become embedded in the Babbitt; especially in soft, high lead Babbitt bearing.
c. Plastic gauge doesn't need skill more and it is easy to identify just comparing the compressed width of plastic with the gauge paper.

27. Why spherical seated bearings are used?

To allow self-accommodation on housing depends shaft aligns.

28. What is bearing crush?



Actually it defines the compression fit of the split type journal bearings diametrically and will not exceed more than maximum of 0.003 inches.

29. How do you check bearing crush?

Keeping 0.004 to 0.010 inches of shim according the plastic gauge series on the face of half split bearing housing and measuring the clearance between the bearing shell and cap (top cover) of bearing housing with the use of plastic gauge after tightening cover.
Now the bearing crush = shim thickness – plastic gauge reading.

30. How do you adjust bearing crush?

By providing shim piece in-between bearing shell and top cover of the bearing housing.

31. How do you check thrust-bearing clearance?

Keep the dial indicator horizontally on rotor in any accessible point. Move the rotor shaft longitudinally to find out the thrust clearance of the bearing after fixation of radial and thrust bearings.

32. How do you adjust thrust-bearing clearance?

Add or remove shims on the thrust-bearing collar if provision given otherwise
Machining carried on in case of no other way.

33. How do you identify bearing pads based on their pivot?

Left hand and right hand pads.

34. How do you identify RH & LH pivoted pads?

If the loading point of pad on the right side called RH pads when seeing in front of the pad face. If the loading point of pad on the left side called LH pads when seeing in front of the pad face.

35. If the DOR of a rotor CW looking from C/E, where will you locate RH & LH pads?

Right hand pads on opposite side of coupling end.
Left hand pads on the coupling side.

36. What is adaptor sleeve & withdrawal sleeve?

These sleeves used to fix and remove bearings easily on that and to be fixed any accessible place on the rotor. In adaptor sleeve, bearing is fastened while the adaptor sleeve nut tightened. In withdrawal sleeve nut is used to withdraw bearing from its position from the withdrawal sleeve.

37. How do you specify a bearing lock nut & lock washer?

N - for bearing locknut, **W** - for bearing lock washer

38. What is rotor free float?

It defines the total axial movement of rotor without thrust bearing.

39. Explain rotor centering?

It is the process of keeping rotor half of the free-float through the position of thrust bearing in the bearing housing fixation.

40. How do you adjust rotor centering without affecting axial float?

Increase or reduce the thickness of centering spacer fixed behind the thrust bearing on shaft. Add or remove gasket on the end covers of bearing housing. It allows only slight adjustment otherwise machining carried out on end cover in case of no other way.

41. What is radial centering?

Aligning the rotor axis in the same line with centerline of casing confined recess provided for the fixation of wear ring, neck bush, etc. radially. This centering keeps and helps to maintain constant gap between wear ring, neck bush, etc.

42. How do you adjust radial centering?

By the use of adjusting screws provided on the bearing housing carrier.

43. Explain the overhauling sequence for a multi stage centrifugal pump?

Pump made: **PACIFIC** model: **R X 1J. 9**

1. Remove coupling, hub with the use of puller
2. Remove bearing housing top covers of both in board and out board sides
3. Take out journal and thrust bearing in the out board side and journal bearing in the inboard side
4. Dismantle bottom bearing split housing of outboard side.
5. Remove thrust collar from shaft.
6. Remove all seal parts from head on both sides
7. Cover the shaft on the bearing seated surface finished area by tape
8. Loosen and remove the head bolts connected with barrel of pump to let the rotor free to remove after taking out the head from position by the jack bolts provided on the head. Care should be taken about the gaskets, inner and outer and the removal of discharge diffuser case.
9. Fix the fixture to guide the rotor assembly
10. Pullout the rotor assembly including inlet guide vane case, intermediate stage housings with care.
11. Check the key way of barrel
12. Transfer the rotor assembly to workshop for the next step of action
13. Remove tie rods, which connects of all cases and key on the cases.
14. Remove balancing piston by loosening locknut.
15. Dismantle diffuser, stage bush, impeller, impeller keys, inlet guide vanes with diffuser of all stages respectively.
16. Now the dismantling of all parts completed.
17. Proper tracing of parts need to any vision able damage like crack, score, break etc while dismantling
18. The following measurements should be measured and recorded for analyzing the performance like, wear ring clearances, stage bush clearances of all stages, bearing diametric clearance, thrust allowance, shaft trueness, seal setting compression etc while and after dismantling.
19. Care should be taken about all allowable factors with in design limit
20. Changing new parts is better than re conditioning
21. Assembling is the reversible procedure of dismantling before seen. Proper tightening torque should be followed is carry over.
22. Before coupled with drive alignment should be checked and corrected to retain with in limit.

44. What do you mean by wear rings?

Wear rings are removable rings fixed on either impeller eye and casing or both of them.

45. What is the purpose of wear rings?

To avoid the change of impeller and casing due to pitting corrosion.

To minimize the flow of liquid from high pressure of discharge to low pressure of suction eye

46. What are the different types of wear rings?

1.Serrated wear rings, 2. Stepped wear rings, 3. Reverse thread wear rings, 4.thrust balancing wear rings, 5. Flat wear ring, 6. L shaped wear ring, 7. Impeller wear ring, 8.casing wear ring, 9.double ring with labyrinth leakage joint wear ring.

47. How do you check wear ring clearance?

Means of measuring the outer diameter of impeller wear ring or impeller eye and the inner diameter of the casing wear ring inner diameter by the use of micrometer or vernier caliper and with the use of feeler gauge if possible.

48. How do you adjust wear ring clearance?

By machining wear rings or change as new one if the clearance more.

49. How do you fix eyewear ring & casing wear ring?

Interference fit with Allen screw lock, pin with spot weld, direct bead weld, threading etc.

50.What the different types of shaft sleeve?

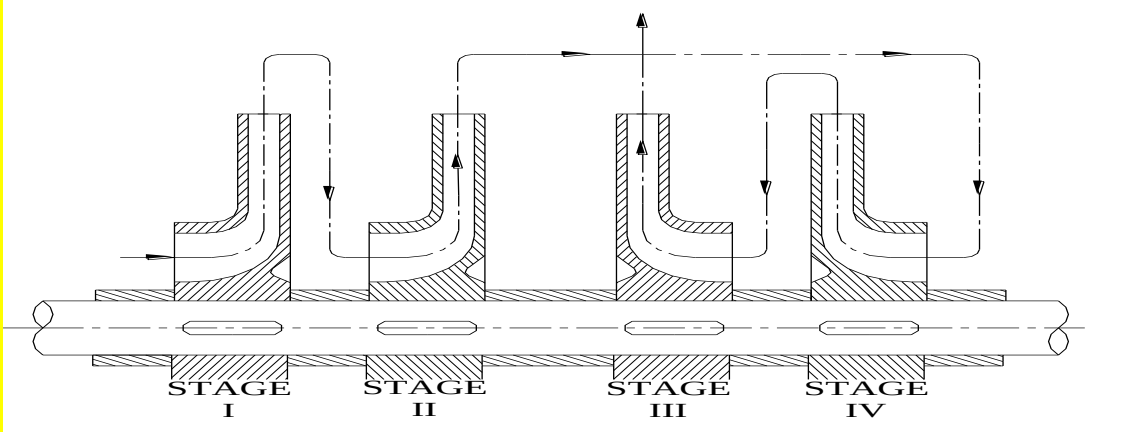
Threaded sleeve, sleeve with locknut, sleeve with Allen lock, straight sleeve, stepped sleeve, throttle sleeve, throat sleeve, etc.

51. Where are throttle sleeve & throat sleeve located in a rotor?

Throat sleeves located on throat bush area to control the flow of pumping liquid in to stuffing box area.

Throttle sleeves are used in slurry service to avoid the flow of slurry liquid into seal area with the use of throttle packing which allows only the flushing liquid into pumping liquid area instead of reversing that's why flushing fluid pressure is kept 15 psi more than suction pressure. ENSIVAL pump design has the provision of both throttle and throat bush arrangement.

52. Draw a balanced opposed rotor arrangement?

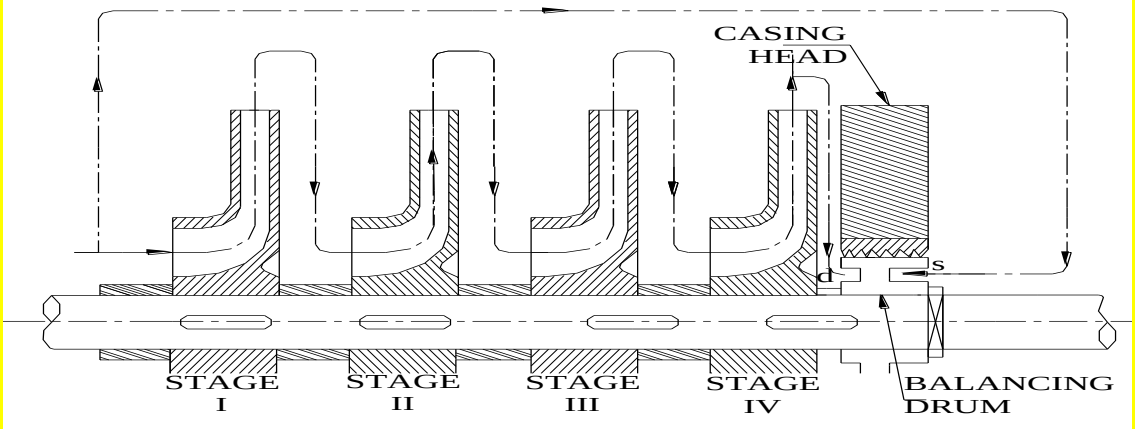


53. Why balanced opposed rotor arrangement is preferred?

This arrangement minimizes axial thrust load of rotor by keeping the low pressures (suction pressure) on both side by the arrangement of impellers.

To attain the critical speed of the equipment apart from the working speed

54. Where is balance drum located in a rotor?



d- discharge pressure side; **s**- suction pressure side

The balancing drum is located, behind the last stage of impeller.

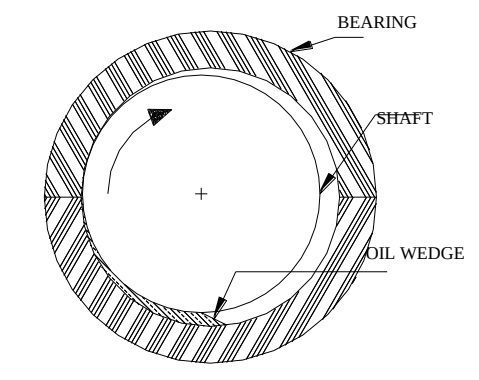
55. What is the purpose of balance drum?

Used to take 90% of thrust load by liquid and the residual thrust is supported by the thrust bearing.

56. What is the applicable API standard for centrifugal pumps?

API 610.

57. What do you mean by oil wedge?



Under normal operating condition, the shaft of the machine will rise slightly up the side of the bearing. The amount of rise depends on shaft RPM, rotor weight and oil pressure. The shaft, thus operating in an eccentric position relative to the bearing center, draws oil to produce a pressurized load-carrying film called as 'oil wedge'.

58. What do you mean by oil whirl and oil whip?

The eccentricity of oil wedge is momentarily increased from its equilibrium position, perhaps due to a sudden surge, an external shock load or other transient condition, additional oil is immediately pumped into the space vacated by the shaft. The result is an increase in the pressure of the load-carrying film. The additional force developed by the oil-film can drive the shaft into a whirling path around the bearing. If the damping within this system is sufficiently high, the shaft returns to its normal position in the bearing; otherwise the shaft continues in a whirling path called 'oil whirl' Lack of lubrication or improper lubrication causes excessive friction between the stationary bearing and rotating shaft, and the friction excites vibration in the bearing and other related parts similar wiping a moisture finger over a dry plane of glass called 'oil whip'.

59. What is hydrostatic lubrication?

The pressurized lubrication oil given on oil wedge for lubricating and creating oil film in-between the moving parts. This type of lubrication called hydrostatic lubrication.

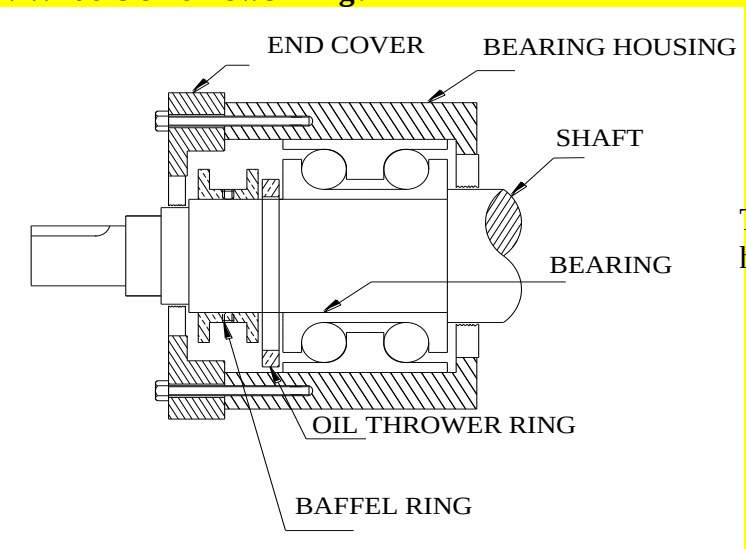
60. What is hydrodynamic lubrication?

The moving parts make the lubricating film in between contact area while running itself. This type of lubrication named as hydrodynamic lubrication.

61. What is forced feed lubrication?

Actually it is a pressurized lubrication, oil wedge formed by the pressure induced from separate lube oil pump, which driven by either separate drive or with drive from running rotor.

62. What is oil thrower ring?

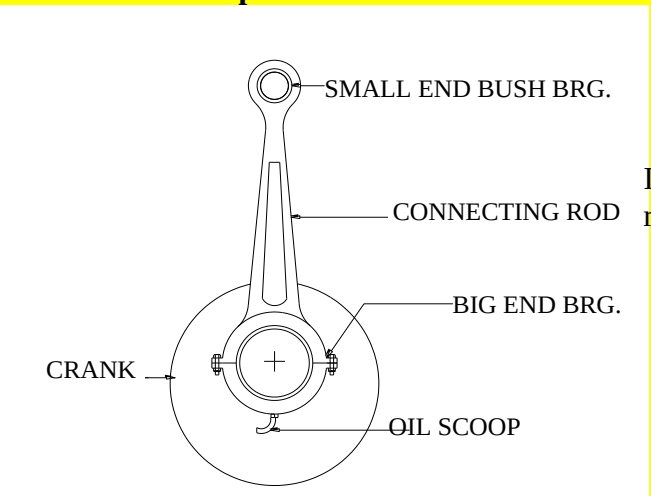


This ring provided on the shaft in bearing housing to make efficient lubrication.

63. What is the purpose of oil thrower ring?

It is used to lubricate the bearing effectively by splashing out lube oil quenched and rotates the contact motion of shaft while running.

64. What is oil scoop?

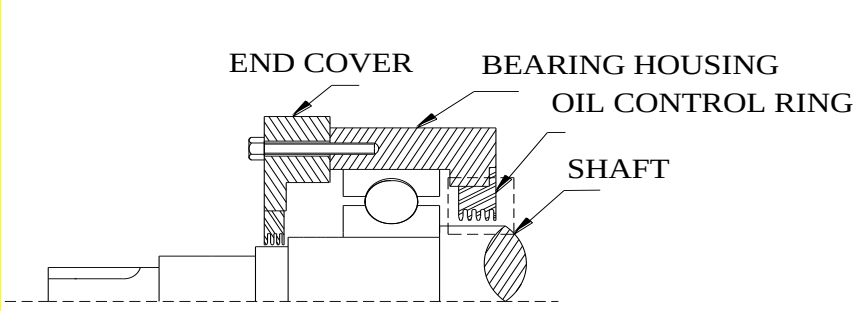


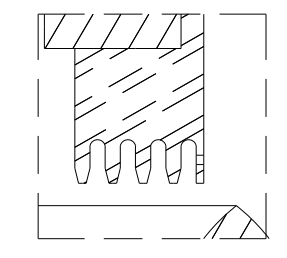
It is a small bucket shaped part fixed on rotate able crankshaft

65. What is the purpose of oil scoop?

Used to splash lube oil intermediately for effective lubrication.

66. What is oil control ring?





A ring made of aluminium, brass or bronze fixed in the end covers of bearing housing.

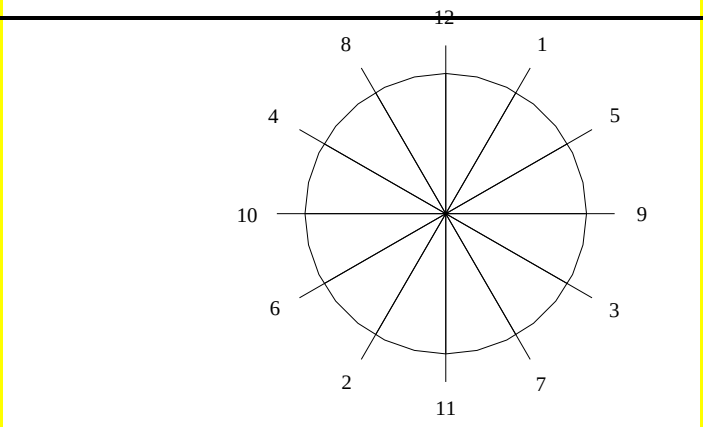
67. What is the purpose of oil control ring?

The labyrinth grooved ring (oil control ring) used to avoid the leakage of lube oil to atmosphere and entry of moisture in to the bearing housing.

68. Why auxiliary lube oil pump is used?

Normally it's a motor driven pumps used, 1. To maintain the lube oil pressure when starting and running time, 2. Auto start, incase of main lube oil pump failure, 3. To give lube oil circulation when the rotor is in ideal.

69. What is the casing bolt-tightening sequence?



70. What is torque wrench?

It's a mechanical tool used for tightening the bolts of equipments with proper torques by the help of the torque indicator attached with it.

71. What is rotor run out?

Rotor run out defines the accuracy of trueness of the rotor. This should not exceed more than 0.002 inches.

72. How do you check rotor run out?

After keeping the rotor on the bearings or lathe center, with the use of dial indicator.

73. What are the various ways of impeller fixing arrangements?

1. Threaded, 2.Sliding fit with key and lock nut, 3.Snug fit with sleeve lock nut, 4.With use of collets 2.

74. What is the general value of rotor run out at various locations?

Impeller- 0.0025"
Sleeve – 0.0015"
Bearing – 0.001"
Coupling – 0.0025"

75. What is NPSH?

Net positive section head= static head + velocity head of liquid – vapor pressure at suction temperature

76. What is NPSH required and NPSH available?

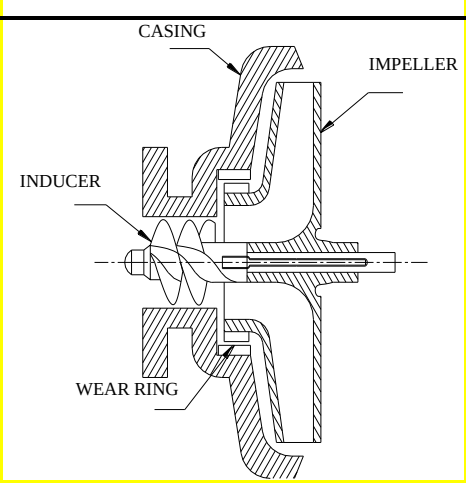
NPSH required establish the pump capability of working in minimum of positive suction head. NPSH available establish the original working condition of pump in process with positive suction head. NPSH available should be more than that of NPSH required.

77. What is cavitation?

Cavitation is the process of air or vapor lock in a pump. Reason for cavitation

1. Wrong NPSH
2. Pin hole or any air leak on suction line
3. Starvation of pump
4. Low velocity of liquid in the suction eye.

78. What is inducer?



A small low head, axial flow impeller that attaches to the conventional impeller is called as inducer.

79. Why inducer is used?

Inducer is used to increase the pump's suction head (pressure), and prevent cavitation problems. The inducer will reduce the net positive suction head required of the pump or permit the pump to run at a higher speed.

Not all pump manufacturers have this feature available.

80. What is different between discharge head and discharge pressure?

Discharge head expressed in feet of the liquid being pumped from the discharge port.

The head varies depends on its discharge pressure.

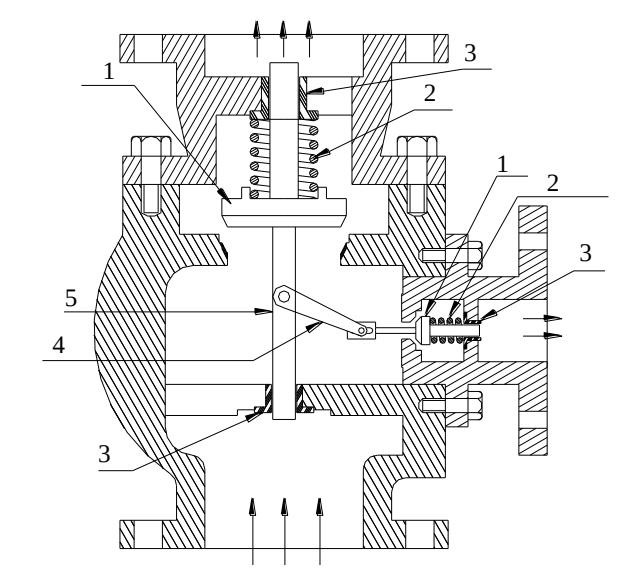
Example: 1 Psi liquid raises 2.32 feet of height of liquid with the specific gravity of 1.

Discharge pressure expressed as Psi.

81. What is minimum flow check valve?

Minimum flow check valve is a non-return valve with a regulating by-pass port in the application of high temperature (near saturation temperature on the discharge) liquid services. Example- boiler feed water pump

82. Why minimum flow check valve is used?



1.Plugs
2.Springs
3.Bushes
4.Connecting Lever
5.Spindle

To avoid the backing of vapor lock in the application of near saturation temperature liquid service by giving circulation of liquid while pump in ideal.

When the pump in ideal condition the by-pass port opens and allows the circulation of liquid and when the pump starts, the by-pass port closes by the action of main check valve opening.

83. What is vertical in line pump?

The pump fixed in the line of flow of liquid itself in vertical axis called vertical in line pump. Actually it is a booster pump for giving extra energy to liquid while flowing.

84.How do you center the rotor and position the coupling of a vertical in line pump?

Normally this pumps have rigid muff split coupling attached with help of Allen screws, the shaft and coupling steps and grooves matched with together while fixing.
Add or remove the metal shims in-between the pump and motor frame for centering the rotor.

85. Explain the procedure for mechanical seal renewal of vertical in line pump?

1. To get proper work and safety aspect from operations
2. Remove coupling and before ensure the compression of seal unit by removing gland bolts.
3. Remove coupling and take out gland plate outside
4. Pull out compression unit (retainer) by special puller, care seal parts
5. Check the packing area of sleeve for fretting corrosion and confirm any other defects in sleeve
6. If the sleeve condition is good assembly of seal can start otherwise sleeve should be replaced by the pump overhauling
7. Assemble is the same reverse procedure of the dismantle procedure before seen
8. While assembling the following aspects should be checked, retainer seating on sleeve slot with lock pin perfectly, seal setting compression, bearing condition of the motor and alignment.
9.

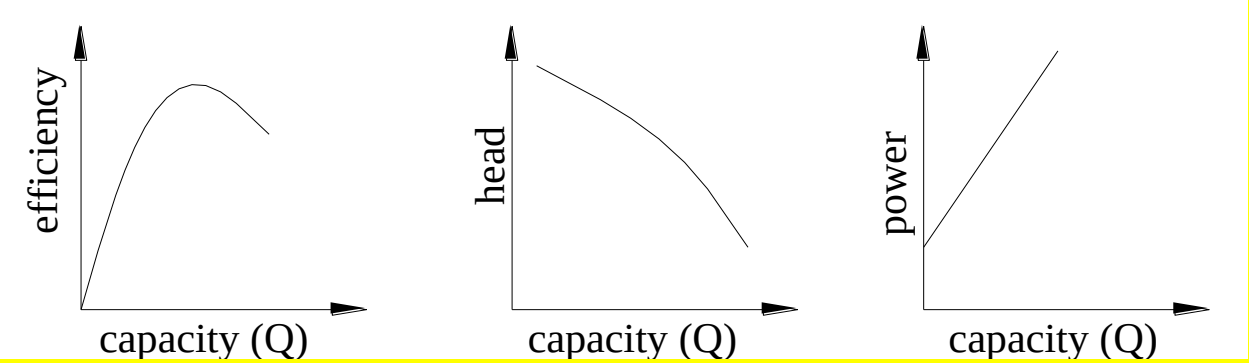
86. What is vertical sump pump?

Vertical pumps designed for suspension in or for mounting in their suction supply, like a sump or wet pit, are called as sump pumps. These are generally automatically controlled by float switches.

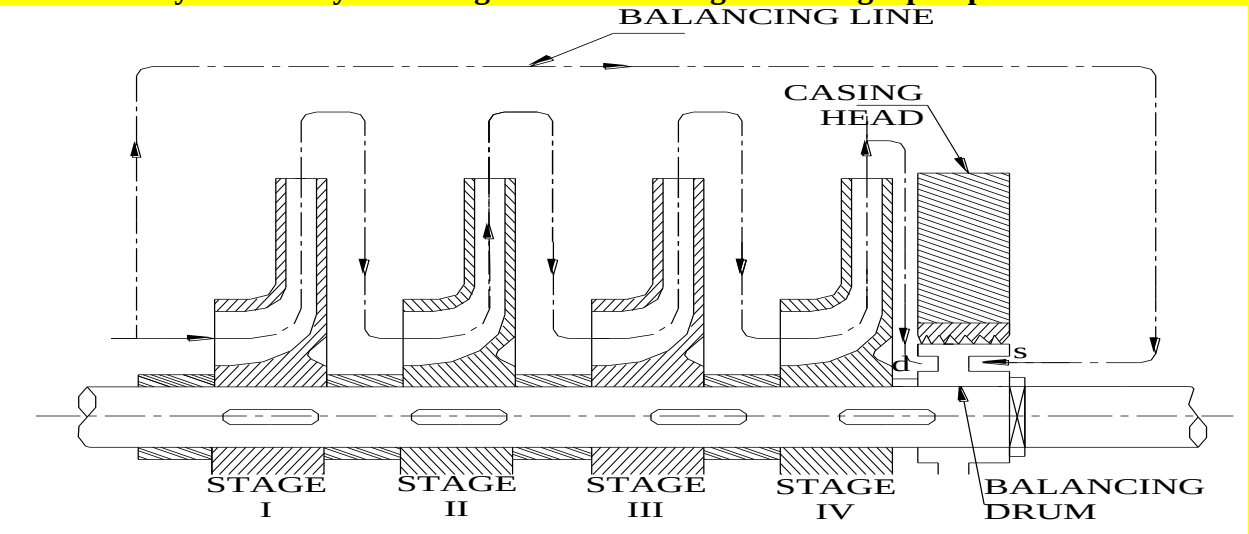
87. What is steady bearing?

Steady bearings are fixed in the vertical pump intermediately between the drop columns. It is actually bush bearing fixed in steady rest housing.

88. Draw the performance characteristic curve for a centrifugal pump?



89. What do you mean by balancing line in multi stage centrifugal pump?



The line connects intermediate labyrinth of balancing drum (discharge side) with the suction port for thrust balancing of rotor named as balancing line in multistage centrifugal pump.

90. What is the purpose of balancing line?

Used for thrust balancing by connects suction port and balancing drum.

91. Why mechanical seals are used?

a. Used for hazardous and toxic liquids, b. Zero leak proof, c. Reliable, d. Less friction loss comparing packing, e. High efficiency

92. How do you specify a mechanical seal?

As per API –682

X_1 X_2 X_3 X_4 X_5

X_1 – Balanced (B) and unbalanced (U)

X_2 – single (S), double (D), tandem (T)

X_3 – Type of seal gland (T- throttle bush, A- auxiliary sealing device)

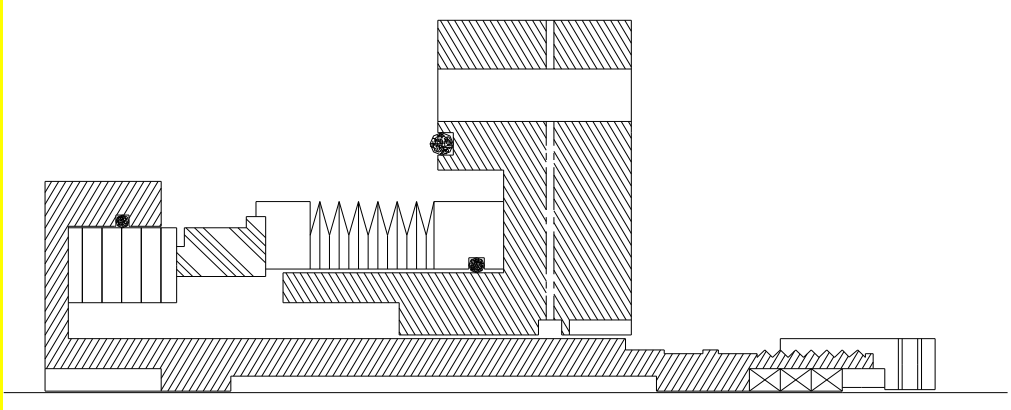
X_4 – gasket material (R- Graf oil)

X_5 – face material (M – means tungsten carbide Vs carbon)

93. Name few seal manufactures?

John crane, Pacific, Borg Warner, Dresser rand, Dura metallic

94. What is 15WRS seal?

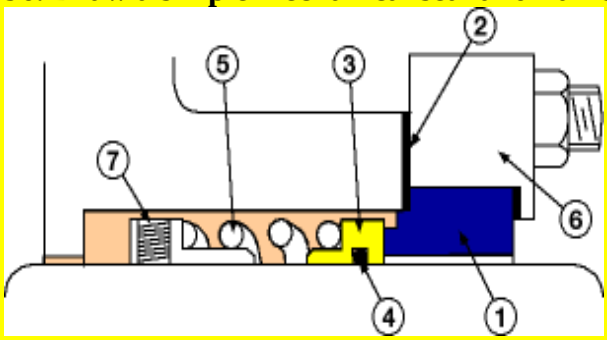


It is a seal made of john crane as per API – 610
in which the seat fixed on sleeve made of tungsten carbide
the bellow seal face made of carbide with grafoil made secondary packings.
It has facility of flushing and quenching provision.

95. Name few types of mechanical seal?

1.Single coil mechanical seal, 2.Multi coil mechanical seal, 3.Balanced mechanical seal, 4.Unbalanced mechanical seal, 5.Pusher/ non pusher mechanical seal, 6.Single/ double mechanical seal

96. Draw a simple mechanical seal and name its parts?



1. Stationary component, commonly called 'the seat'.
2. Stationary component sealing member.
3. Rotating component.
4. Rotating component-sealing member.
5. Spring.
6. Gland Plate
7. Clamp Ring

97.Explain the complete dismantling and assembly procedure for a mechanical seal?

1. Remove the gland from stuffing box to access mechanical seal with care after checking the seal setting compression.
2. Take out sleeve with retainer set and check any vision able effects like carbon crack, struck, wear on facing area both carbon and seat
3. Remove the seat from gland and justify the condition of secondary packing of seat.
4. Remove retainer set by loosing Allen screws before make conform the retainer houses on the shoulder of sleeve other wise take measurement of retainer position.
5. Full view of inspection to be done on each and every mechanical seal parts like springs, thrust plate, drive lugs, snap ring, seat seating area on gland, sleeve surface due to fretting corrosion, seal matting face of both seat and seal ring.
6. Changing new parts is better than reconditioning (lapping)
7. Assembling is the reverse procedure of dismantling on time the following aspects should be check:
    1. Square ness and rectangularity of seat after fixation on the gland plate.
    2. Trueness of the shaft and sleeve.
    3. Correct fit of wedge packing/ "O" ring with backup ring on the sleeve.
    4. The recess confined with gland plate and stuffing box.
    5. Seal setting compression as per drawings or as same before.

98. What is applicable standard for mechanical seal?

API – 682 (shaft sealing systems for centrifugal pump as well as rotary pumps)

99. What is the average life expected out of a seal as per API –682?

2 Years in normal working condition

100. What is seal setting compression?

The seal setting compression given by the retainer in to matting faces as per designed by the suppliers

101. What is cartridge type of mechanical seal?

The seal is mounted on a sleeve that can be secured to the shaft from outside the seal chamber. It's an advance-designed seal supplying by the seal manufacturers to make the installation easier. There is no need measurement while fixing and just changing as new set of cartridge seal instead of reconditioning.

102. Can you change the seal settings compression of a cartridge type mechanical seal?

No.

103. Explain the assembly procedure of a cartridge type mechanical seal?

Is a simple and easy assemble procedure comparing a normal mechanical seal
Just fix the cartridge seal set on the shaft and tight the gland plate with stuffing box. Tight the Allen screws on sleeve to lock with shaft then remove the seal setting lock plate provided on gland plate by loosening the sets screw.

104. How do you identify a balanced / unbalanced mechanical seal?

Identification of balanced seal:

1. Stepped sleeve on seal ring area.
2. Reduced contact area of seal ring by the provision of step.
3.

105. What is pusher/ non-pusher type mechanical seal?

When the secondary packing of seal ring is affected due to the thermal expansion in ambient condition and the axial end movement of rotor called as pusher seal. Otherwise called as non-pusher seal.
Normally pusher seals are single & multi coil mechanical seals and non- pusher seals are bellow seals.

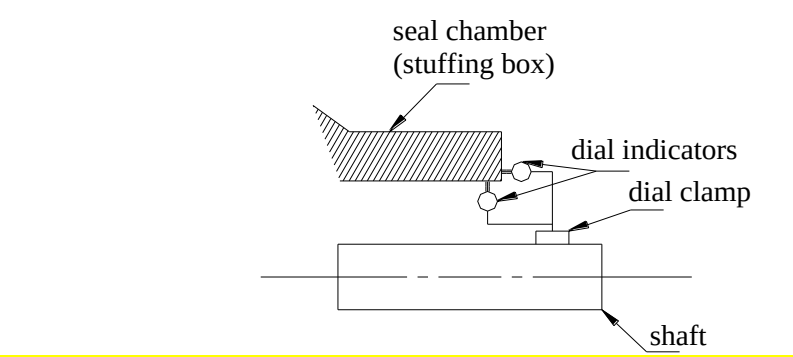
106.What are all the pre check to be made on a pump before starting positioning a mechanical seal?

Shaft true ness, Stuffing box bore square ness, Shaft deflection, Thrust movement of rotor, Dust free condition

107. What is stuffing box square ness?

It's a process of checking the concentricity of stuffing box bore with shaft rotation by the use of dial indicator. The maximum allowable square ness is 0.0025"

108. How do you check stuffing box square ness?



109.What type of mechanical seal prefer for hot oil? Why?

Non-pusher seal (bellow seals) to avoid fretting corrosion due to thermal elongation.

110. What type of mechanical seal prefers sulphur duty?

Single coil mechanical seal with seal ring made-up of carbon and matting ring made – up tungsten carbide to with stand high temperature distortion and slurry service.

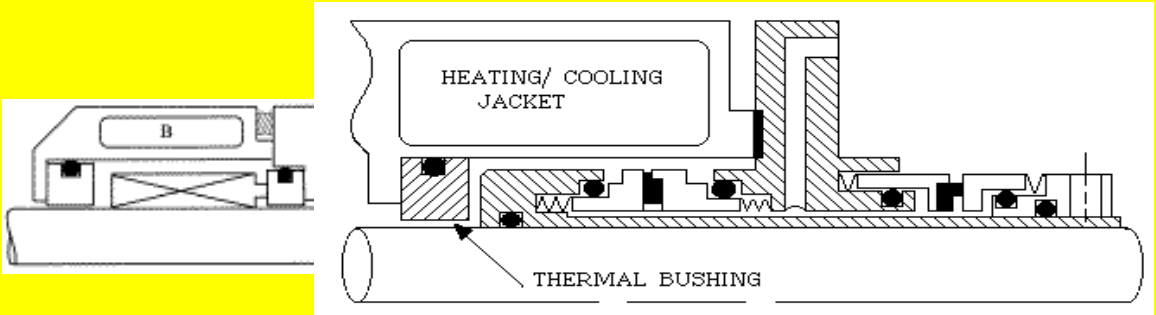
111. What is seal flushing fluid? Name few seal plans?

Seal flushing fluids used in the mechanical seal system for cooling, cooling and lubricating the mating seal faces.

112.What is seal quenching fluid? What is its purpose? Name few seal plans?

Seal quenching fluid used behind the mechanical seal system in the gland plate design provision to avoid the hazardous or toxic liquid with atmosphere if the seal leaks in the form of liquid or gas state.

113.What is stuffing box cooling water jacket? Why it is used?



The integral or removable jacket provided in the pump for circulating the cooling water to maintain the stuffing box temperature into desirable limit for attaining the mechanical seal life reliable.

114. Why seal coolers are used?

To reduce the temperature of flushing fluid while entering into the mechanical seal system to maintain stuffing box temperature and better lubrication in the seal mating faces in running condition.

115.Name few MOC of seal faces?

Carbon, tungsten carbide, silicon carbide, stellite, ceramic, bronze, cast iron, etc.

116.What is seat ring and mating ring?

The ring has the provision (springs or bellows) to give seal setting compression called as seat ring. The ring mates with seat ring for sealing called as mating ring.

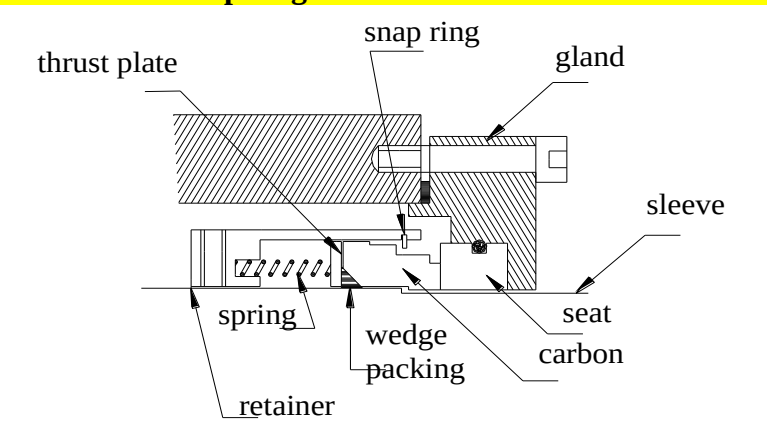
117.How many elastomers are used in a mechanical seal assembly?

1. Between seat ring and sleeve or shaft, 2.Between mating ring and gland plate, 3.Between shaft and sleeve, 4.Between gland and stuffing box.

118. Name few MOC of elastomers?

Neoprene, viton, glass/ asbestos filled Teflon, Graf oil, Buna-N, buna-S, etc.

119. What is snap ring in a mechanical seals?



Snap ring is a cut off circular ring used to hold seal ring with advance - compression. Snap ring rests on the groove made on retainer.

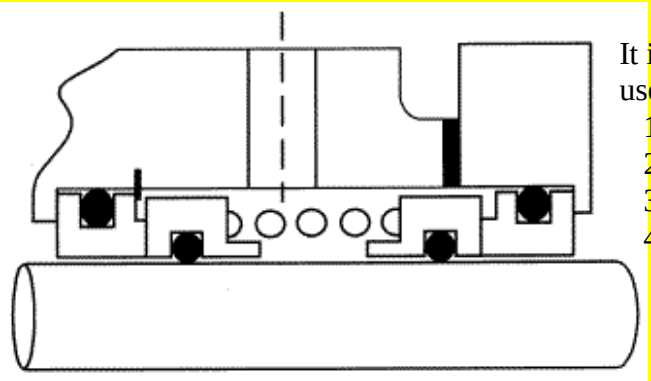
120. What are the usual problems faced with mechanical seals?

1. Sleeve fretting corrosion
2. Retainer springs struck
3. Seat or mating ring crack
4. Lack of reliable of secondary packing
5. Excessive wear of mating faces, etc.

121.Does the axial float have something to do with mechanical seal?

Yes. Seal setting compression will change.

122.What is double mechanical seal? Why it is used?



It is the two sets of simple mechanical seal. It is used in the application of;

1. High hazardous of pumping liquid
2. Usage of separate flushing fluid
3. A seal leak could cause a pollution problem
4. The product is very costly

123.Name two types of mechanical seal? Where is it used?

1. **Back to back**. The worst possible choice if used in the rotating seal version. Stationary versions are acceptable because the sealing fluid is located at the outside diameter of the seal faces where we can take advantage of centrifugal force
2. **Tandem**. One seal behind the other requiring a low pressure buffer fluid between the seals. This arrangement cannot be used if a higher-pressure barrier fluid is required or desirable.

124. What do you mean by barrier fluid? Name few barrier fluid?

Any time you use two seals in an application you will need a fluid between them. If the fluid between the seals is higher than stuffing box pressure we call it barrier fluid
Water is a good barrier and buffer fluid.

125.What do you mean by buffer fluid? Name few buffer fluids?

If the fluid between the seals is lower than stuffing box pressure we call it buffer fluid.

126. What is the difference between barrier fluid and buffer fluid?

Any time you use two seals in an application you will need a fluid between them. If the fluid between the seals is higher than stuffing box pressure we call it barrier fluid. If it is lower than stuffing box pressure we call it buffer fluid. The liquid can be circulated either by forced circulation, a pumping ring or convection. The method that you will use will be dictated by the pressure, pump speed and shaft size. Water is one of the best barrier or buffer fluids because of its high specific heat and good conductivity. Petroleum oil is probably one of the worse because of its low specific heat and poor conductivity

127.Where do we use cyclone separator in a mechanical seal?

In the application of the stuffing box pressure is more than the suction pressure of the pump to separate the foreign materials if anything in flushing fluid from the discharge of the pump by the action of centrifugal force.

128.What is pumping ring in a mechanical seal? What is its purpose?

The thermodynamic grooves feature made on the ring or the circumference of the retainer of the seal system is named as pumping ring. This has two types of radial and axial pumping ring. Used to give circulation and pressure to flushing fluid

129.What is the difference between inside mounted seal & outside mounted seal?

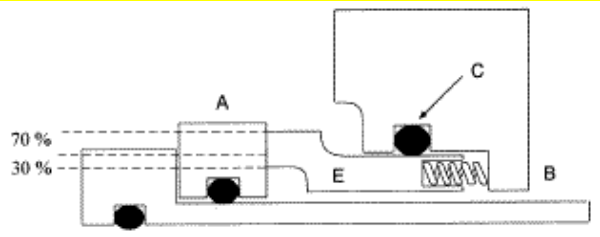
The inside mounted seal. All components are in the pumping fluid.

- **Advantage**. The elastomer can move to a clean surface as the seal face wears. Centrifugal force throws solids away from the seal components allowing the lapped seal faces to stay in co
- **Disadvantage.** All the metal components must be corrosion resistant to the pumping fluid.
- If the product solidifies or crystallizes when the pump is stopped, the seal can become inoperable.

The outside mounted seal. None of the metal components are in contact with the pumping fluid. Most designs clamp to the shaft rather than using setscrews that damage ceramic or glass coated shafts.

- **Advantage.** This is the most common solution to non-metallic pump sealing.
- **Disadvantage**. Centrifugal force throws solids into the lapped seal faces and can prevent the sliding components from moving freely. Higher pressure applications can cause the retaining clamp to slide on the shaft

130.What is seal balance ratio?



It is the ratio between the effective area of fluid pressure acting and the loading area of mating seal faces. It is actually defines the balancing of hydraulic forces.

131. What is the seal balance ratio for balanced/-unbalanced seal?

For balanced seal- 0.75; For unbalanced seal- 1.25 to 1.35

132.Differenciate centrifugal pump and reciprocating pump?

Centrifugal pump:

1. Working in the principle of centrifugal force
2. The main part is impeller
3. In the application of high capacity
4. Constant pressure with variable capacity
5. High efficiency

Reciprocating pump:

1. Working in the principle of reciprocating compression
2. The main part is piston/ plunger
3. In the application of high pressure
4. Constant capacity with variable pressure
5. Low efficiency

133.How do you measure Valve lift in a reciprocating pump?

In feather plate valve type the valve lift is equal to the thickness of the spacer used in-between seat plate and spring (cushion) plate; valve lift – 0.8 to1.5 mm. For the wing disc valve type it is the gap between disc top faces with the valve cover; valve lift- 3 to 6mm.

134.What is the necessity of pulsation dampener?

To minimize the fluctuation of flow of liquid in the reciprocating pump (+ve displacement).

135.Name few types of pulsation dampener?

1. Bladder, 2.Diaphragm, 3.Mechanical, 4.Bellow

136.How do you fill up gas in an accumulator?

Gas is filled in an accumulator by the use of flow regulator valve into the desired pressure, which is normally 40 to 70% of the working pressure of the line to be damp.

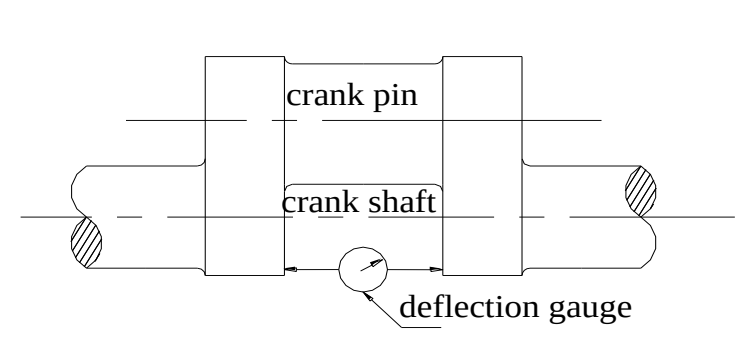
137.Explain overhauling sequence for a reciprocating pump?

Pump made: **QUINTUPLEX WILSON**

1. Get clearance from operation, drain out liquid and electrically isolate as per safety
2. Remove cylinder head cover, top cover and take out suction and discharge valves. Check any damage of damage of valves and valve parts of all stages.
3. Remove plunger by rethreading with stub shaft and take out. Remove neck bush.
4. Dismantle stuffing box assembly include gland and packings. Take out cylinder head by removing bolts from crankcase frame.
5. Rethread stub shaft from cross head to take out
6. Open the crankcase cover behind after drain out crankcase lube oil

7. Dismantle coupling spacer to disconnect driver and free rotation
8. Remove connecting rod big end cup and split bearing and take out connecting rod with cross head outside from recess towards head side of all stages
9. Now only a part of crankcase with crankshaft available for further inspection.
10. Check crankshafts of any damage, web deflection, ply and thrust clearances. If you have doubted about any remark take out crank shaft from case and do necessary action to rectify.
11. Perfect inspection to be done on each and every part for any damage, score, marks, white metal pieces and tidy.
12. Assembling is the reverse procedure of dismantling and the following factors should be considered while and before assembling are valve lift, end clearance, neck bush clearance, cross head clearance, rod run out, cross head clearance, connecting rod big and small end bearing clearances, crank shaft main bearing clearance, web deflection, free rotation, alignment, etc.

138.What is web deflection? How do you measure web deflection?



Any movement of crank webs from their ideal position during the 360-degree rotation of the crankshaft is web deflection. It is measured with the deflection meter or electronic web deflection system.

139.How to check big end bearing & small end bush clearance?

Big end bearing clearance:

Keeping dial indicator on connecting rod and lift it by a jack

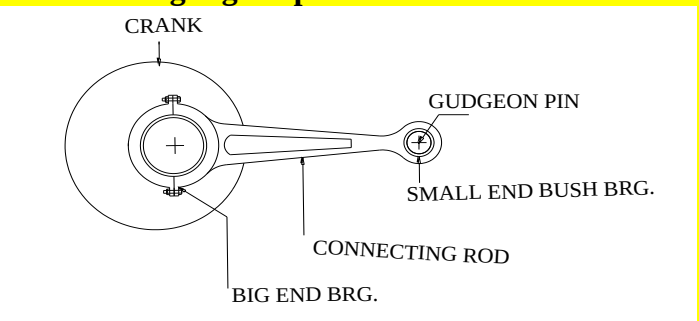
Small end bearing:

By measuring outer diameter of gudgeon pin with inner diameter of bush in the small end or with the use of dial indicator or feeler gauge or plastic gauge which is adaptable.

140.What do you mean by stroke length?

The traveling length of piston/ plunger from BDC to TDC. It is the equal to the distance between crank pin center to crank shaft center.

141.What is gudgeon pin?



The pin, which connects the small end bush of connecting rod with the piston or cross head. The pin is well hardened to with stand tensile and compression load acting on the piston/ plunger.

142.What is crosshead slide/ shoe?

It is the two Babbitt lined adjustable shoes fixed to guide the reciprocal motion of the crosshead with an allowable clearance.

143.Name few ways of locking arrangement of piston/ plunger?

1. Threaded with locknut, 2.Flanged bolted, 3.Locked by pin, 4.With split threaded coupling

144. How to ensure in-line concentricity of crankshaft to cylinder bore?

Keeping the two-dial indicators on the piston/ plunger rod with 90 degree of position and checking the deflection run out of the longitudinal movement of the rod on both sides when rotating crankshaft. The maximum deflection should be less than that of neck bush clearance otherwise the position of cylinder bore with crankcase is adjusted to attain the reading with in limit.

145.What are dosing pumps?

These are all the tiny low capacity reciprocating plunger pumps.

146. Name few types of dosing pumps?

1. Simplex
2. Duplex
3. Multiplex
4. Single acting
2. Double acting
3. Horizontal
4. Vertical

147.Why dosing pumps are used?

Dosing pumps are used to pump a low capacity liquid injected into a high-pressure process operation.

148.What are the probable reasons for cylinder knocking in a reciprocating pump?

1. Valve seat or parts damaged, 2.High temperature of pumping fluid, 3.Foreign materials in suction area, 4.Valve holder looseness, 5.Plunger looseness, 6.Air / gas mixed on liquid, 7.Flow restriction, etc.

149.What are the probable reasons for valve knocking in a reciprocating pump?

1. Worn out seating area, 2.Springs broken, 3.Valve holder looseness, 4.Improper valve lift
5.Valve loose by improper tightening, 6.Reusing worn parts, 7.Foreign matters in valves, etc.

150.What are the probable reasons for vibration in a reciprocating pump?

1. Foundation looseness, 2.Cylinder or valve knocking, 3.Misalignment, 4.Worn parts, 5.Failure of vibration dampener, 6.Wrong installation and assembly, etc.

151.Where do we use screw pumps & gear pumps?

In the application of moderate pressure and capacity & constant capacity with variable pressure requirement.

152.What do you mean by flute?

Flute is a helical wave formed on the screws of the screw pump. In between the flutes pumping fluid passes.

153.What is idler screw?

The screw on the screw pump driven by the engagement of the flutes of the main screw coupled with prime mover.

154.How drive is transmitted to idler screw?

Through the engagement of the flutes of main screw of the screw pump.

155.How do you measure radial clearance & axial clearance between flutes?

Radial clearance; With the use of feeler gauge

Axial clearance; Keeping the dial indicator on the main screw shaft end and moving it longitudinally.

156.How do you measure gear backlash?

With the use of feeler gauge or dial indicator measurement reference with pitch diameter of the gear.

157.What is the usual gear hardness value?

Gears made of alloy- steel; maximum hardness value – 38 HRC & pinion 2 HRC more than gear.
Gears made of hardened alloy steel; surface hardness up to 60 HRC.

COMPRESSORS

158.Name few parts of a centrifugal compressor?

1. Rotor
2. Casing
3. Diaphragm
4. Diffuser
5. Labyrinth
6. Seal
7. Bearings, etc.

159.What is the applicable standard for centrifugal compressor?

API- 617

160.How do you specify a centrifugal/ horizontally split compressor?

MCL- horizontal split type centrifugal compressor, simply specify as 'M'.
as per the design of BHEL.

161.How do you center a compressor rotor?

Measure the total float, which is the axial displacement of the rotor with out thrust bearing and with journal bearings on both sides to avoid the rest of rotor on the labyrinth edges.
Now the centering of rotor is the half of the total float while the thrust plate loaded on the active side of the thrust bearing and is achieved through:

1. Increase/reduce the width of centering spacer fixed behind the thrust plate
2. Machining on the active thrust bearing collar and adding spacer behind the in active thrust bearing
3. Add/ remove the shims on the thrust bearing if the adjustable requirement is less.

162.Explain the overhauling steps for a barrel type centrifugal compressor?

Compressor made: **CLARK** model: **2B F3**

1. Proper safety clearance getting from concerned operation
2. Remove coupling spacer from driver, turbine or motor. Remove coupling by use of coupling puller like hydraulic puller or special tools
3. Before check the thrust clearance of the compressor shaft with thrust bearing
4. Before you to do remove the head should be check that all oil lines are dismantled
5. Remove cover and remove the instrument probe like thrust and radial probe with help of instrumentation
6. Remove bearing housing cover and take care cover gasket for maintaining thrust clearance
7. Remove thrust bearing and thrust disc by removing of locknut
8. Remove split journal bearing two side and make mark, which side coming
9. Remove seals like floating seal with 3 rings. Remove shear ring by use of special tools and should be measure dimension were its locked and inspect the anti lock pin ok or not
10. Remove head locking shear ring and pull up the head by use of jack bolt and special puller. Use lifter to tight with head and transfer to safe place
11. Before removing the rotor, you should tight the diaphragm and rotor itself by use stud bolts for no need to remove one by one, pull out rotor with diaphragm to end position of barrel casing.

12.Use bellyband like clamp for holding and transfer the rotor and diaphragm to where you need.

13. Remove split diaphragm and clean well. Check the rotor any damage and check the wear ring clearance, inter stage labyrinth clearance, rotor balancing, run out
14. Perfect inspection to be done on each and every part for any damage, score, marks, white metal pieces and tidy.
15. Assembling is the reverse procedure of dismantling and the following factors should be considered while and before assembling rotor run out, balancing the rotor and check the interstage labyrinth clearance, check the seals are properly seated, bearing clearance thrust and radial

163.How do you leak check a barrel type compressor?

The compressor pressurized to operating pressure by an inert gas like N_2 . the shaft turn slowly with seal oil delta pressure 0.5 Kg/ CM^2, and leakage seal across HP seals is measured with this, it is possible to judge the fitness of the seals.

164.Explain the overhauling steps for a horizontally split type centrifugal compressor?

Compressor made: **DEMAG** model: **08 MH54**

1. Remove coupling guard and coupling to disconnect from driver. Ensure auxiliary lines are disconnected from compressor like suction and discharge lines, lines for lube oil, seal oil, buffer gas, etc.
2. Remove bearing case of inboard with top split of compressor and remove end cover and out board bearing split case from the top split casing.
3. Let the top casing free and remove casing bolts and pulled up top casing using jack bolts
4. Provide guide rods before lifting to avoid any impact of parts and safe guarding labyrinth
5. Now we can check all viewed parts of rotor, diaphragm visually for any damage
6. Check free rotation, bearing radial and thrust clearance before dismantling and record readings
7. Dismantle and remove seals of both side and after bearing retainer and top bearing split house of both sides
8. Take out rotor from its position carefully
9. Remove bearing bottom housing and inspect each and every parts for any damage, score, rub, wear of labyrinths of all places, diaphragms, ports for seal oil, buffer gas
10. Recondition is better than changing new one. Keep always one rotor as standby to overhaul
11. While assembling fixation of seal should be followed after the top case boxed up. Use proper sealing compound in-between joints of upper and lower casing.
12. Assembly is the reverse procedure of dismantling. The following factors should be checked while and after assembling are, labyrinth clearances of all areas, ports free condition, proper seating of parts and ‘o’ rings, clearance between seal rings and bushings, bearing radial and thrust clearances, measurements with in design, free rotation, alignment, etc.

165.How do you check labyrinth clearance for a barrel type centrifugal compressor?

Securing the half split labyrinth with together by a hose clip firmly and checking the measurement difference with use vernier or micrometers.

166.What is the compound used in the split half of the casing?

Copalite, key-paste, permatex, RTV-60.

167.Name the different types of labyrinths?

1. Conventional labyrinth seal, 2.Straight type labyrinth, 3.Stepped labyrinth, 4.Knife edge labyrinth, 5. J type labyrinth, 6.Turbine type labyrinth, 7.Honey comb labyrinth

168.How do you measure labyrinth clearance in barrel type compressor?

Securing the half split labyrinth with together by a hose clip firmly and checking the measurement difference with use vernier or micrometers.

169.How do you measure labyrinth clearance in horizontally split type compressor?

1. With the use of feeler gauge
2. Securing the half split labyrinth with together by a hose clip firmly and checking the measurement difference with use vernier or micrometers.

170.What is diaphragm?

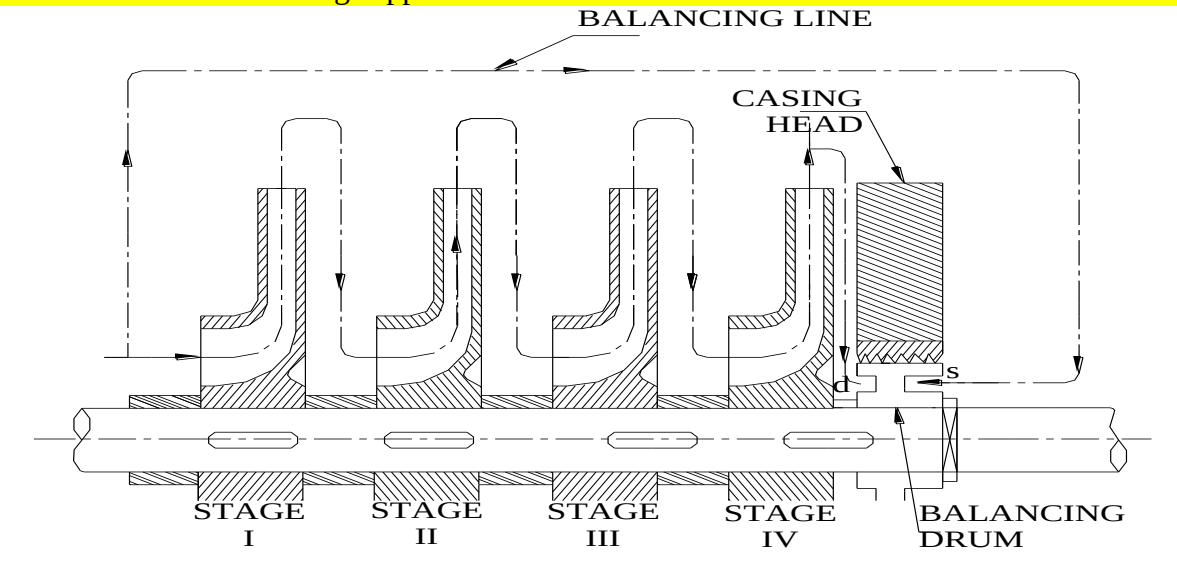
It constitutes the dynamic profile of the stator parts of the compressor. Then are divided into three types viz. suction, intermediate and delivery. Suction diaphragm guides the gas to the first impeller. Intermediate diaphragms have the function of transforming the kinetic energy into pressure, return to channel serves to guide the gas to the next impeller with shock less entry. It has contoured passage leading from the diffuser of one stage to the impeller of the next stage. Some diaphragms are constructed with baffled passages for the flow of coolant. Delivery diaphragm forms the diffuser for the last impeller and delivery spiral.

171.What is diaphragm delta P and what is the maximum value allowed?

It is the pressure difference between entry and discharge in diaphragm of fluid

172.What is balance piston?

The balance piston or drum fixed behind the last stage of impeller to take 90% of thrust load by gas and the thrust bearing supports the residual thrust.



In balancing piston the area in suction pressure side through balancing line is more comparing discharge side of last stage of impeller. Labyrinths on the balancing drum effects to reduce leak off between the both sides of pressure acting.

173.What is balance piston delta P and what its normal value?

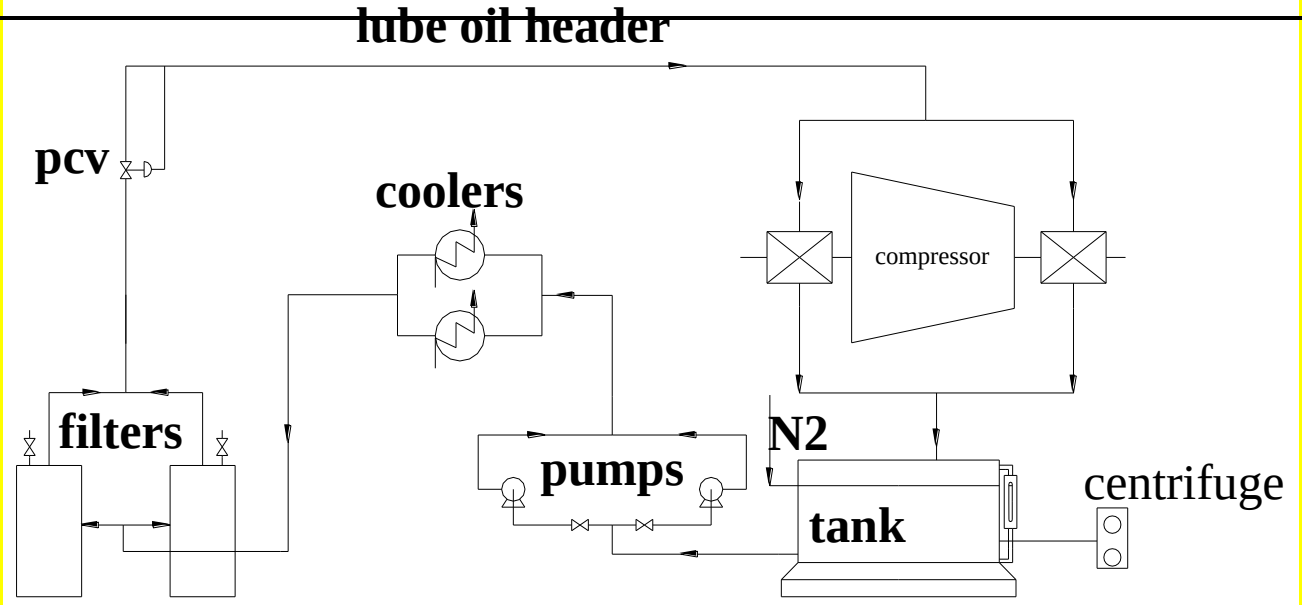
Practically it is the pressure difference of suction and discharge.

174.What is bridge over arrangement?

Bridge-overs are provided to reduce the number of compression stages and the omission of an impeller in the rotor assembly is

1. To provide an internal for a large side stream in connection
2. To make the critical speed of rotor out of normal operating range
3. To avoid interrupt of adjacent nozzle flanges each other.

175.Draw the lube oil circuit?



176.What is lube oil run down tank?

It is an overhead tank for lube oil to supply for bearing lubrication in case of emergency purpose when the both lube oil pump failured, designed still the rotor stops and coming into atmosphere temperature.

177.What is the normal filtration size of LO & SO filter?

Lube oil filtration size- 20 to 40 microns
Seal oil filtration size- 10 to 20 microns

178.What is the purpose of PCV?

The pressure control valve is used to maintain the pressure of the seal oil in the header line.

179.What is the purpose of LCV in the seal oil circuit?

The temperature control valve is used to maintain the level of seal oil in the overhead tank.

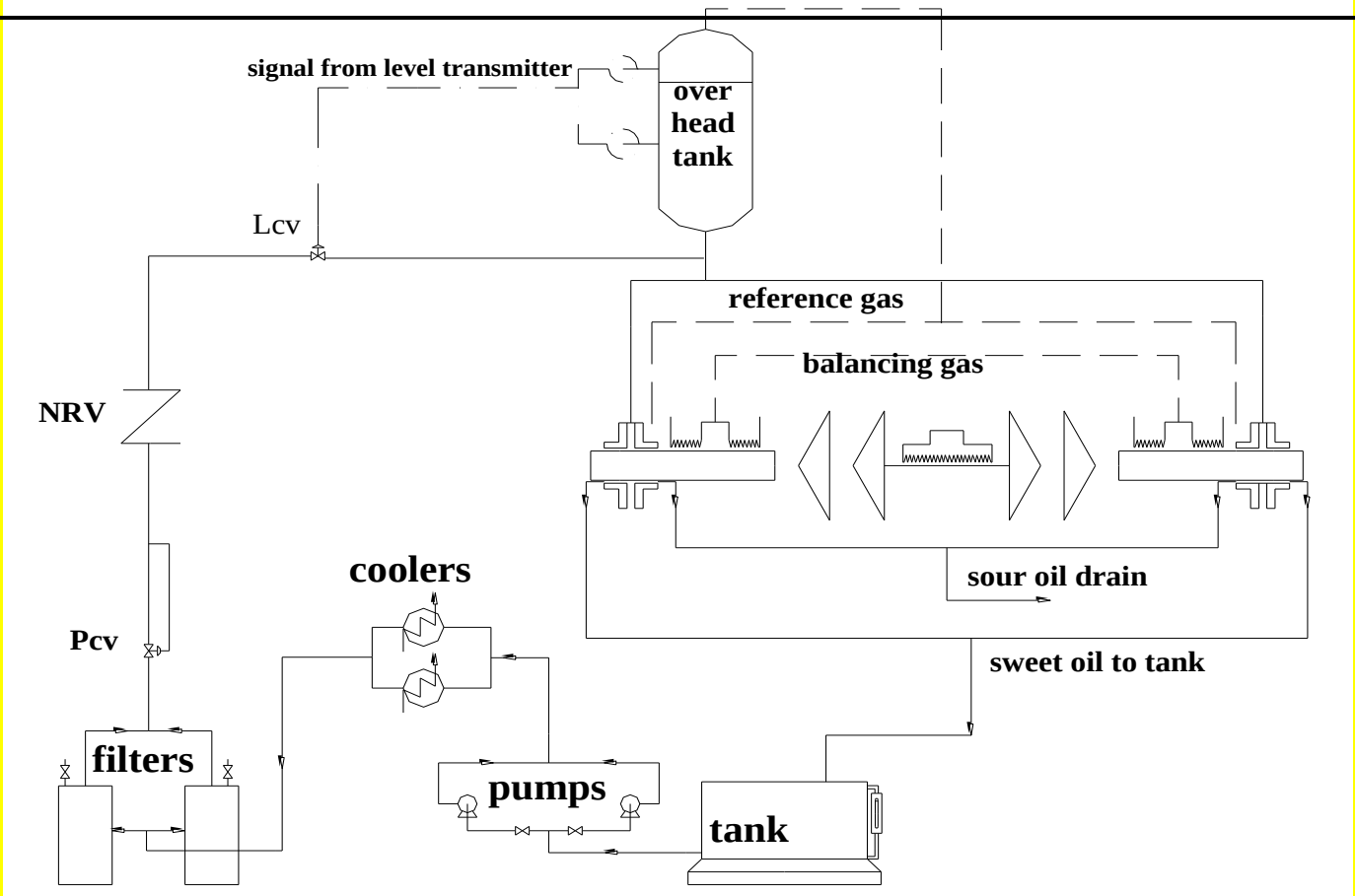
180.What will happen if PCV opens more?

1. The pressure of the seal oil header increases
2. The level in the over head tank increases
3. LCV tends to open more to lower the level of over head tank

181.What is flow through valve?

The recycle gas compressors are applied 3 rings seal configuration because of high sealing pressure. However at start up operation handling gas pressure for regeneration is so low that insufficient seal oil quantity makes over heat of seal rings if seal system is used as is so, this is considered to solve such problem at start up operation by apply by-pass flow (flow-through) system with the use of a control valve called as flow- through valve.

178.Draw the seal oil circuit?



183. Why buffer gas is used in the seal oil circuit?

The buffer gas is an inert or non- hazardous gas used in the seal oil circuit to avoid the contact of process gas with the seal parts and seal oil, if the process gas has hazardous or toxic or corrosive. The buffer gas pressure is normally 7 psi more than that of process gas.

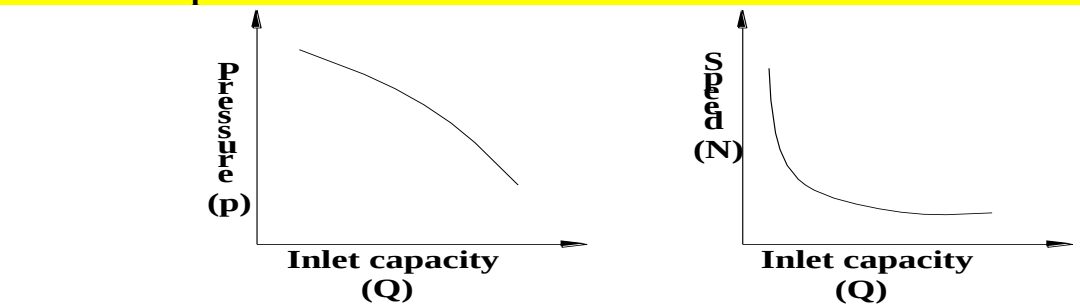
184.Is there any other source for isolating the seal oil from process gas?

Yes. Dry gas seal.

185.What is dry gas seal?

It is a non- contacting gas lubricated seal compressor seal with controlled buffer or flushing gas. They have a rotating seat with a broad face and V grooves. When the seat rotates, the V grooves force gas between the sliding faces. The resulting rise in pressure causes the sliding faces to lift off and run with out making contact.

186.Draw the performance characteristic curve?



187.What is polytropic head & polytropic efficiency?

Polytropic head (H);

The work usually required to compress unit gas flow along the polytropic compression curve is called polytropic head. i.e. actual head developed by the compressor.

Polytropic efficiency;

It is the ratio between the power required to develop polytropic head in to the power actually supplied.

188.What is surging?

Surge can be defined as the capacity below 55 to 70%, which the centrifugal compressor performance becomes unstable. When surging occurs, the high-pressure gas at the discharge of the machine flows back through the compressor in a complete reversal of the normal direction of flow causing the collapse of pressure producing ability will repeat and cycle through the same sequence. Surging controlled by;

1. Increase the flow from process to compressor suction
2. By-pass some discharge through coolers, back to suction of the unit
3. Decrease the pressure ratio.

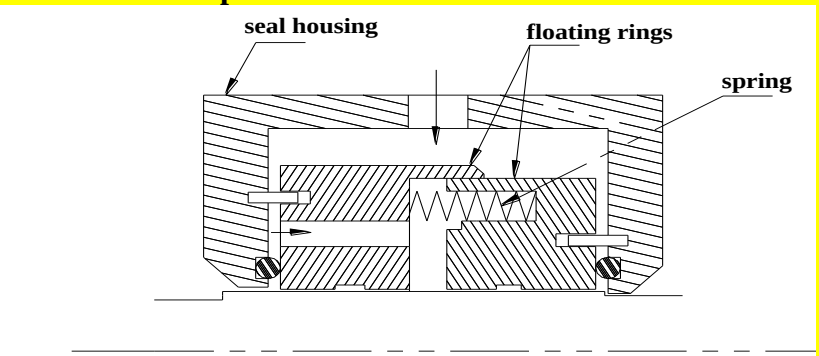
189.What is stone wall effect?

Chocking or stone wall effect is in the large flow region, if the flow velocity reaches sound velocity anywhere in the compressor. The compressor can't generate the head and all input energy are spend to over come the friction.

190.What is stalling?

Is a performance of vortex gas flow generated in the impeller internal or diffuser area as a symptom of surging when gas flow is decreased. To accompany this phenomenon, resonance of impeller and vibration sound (humming sound) will be generated. For corrective measure increase compressor flow. Simply stalling means fluctuation in flow rate.

191. Draw a simple seal?



192.What is contact type & non- contact type seal?

The sliding faces of seal mating together when running called as contact type seal.

The sliding faces of seal with out mating contact with together when running called as non-contact type seal.

193.Is the seal rings stationary, rotating or floating?

Floating.

194.How do you measure seal ring clearance?

With the use of vernier caliper or micrometers.

195.Does the seal ring have clearance with housing? Why?

Yes. Because of floating on its position.

196.What is the general value of seal ring clearance?

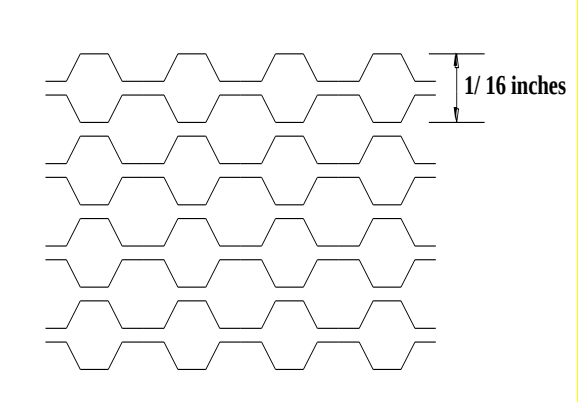
Inner seal ring (gas side) – 0.002 to 0.004 inches

Outer seal ring (oil side) – 0.005 to 0.006 inches

197.What is dummy bearing?

It is a temporarily made of aluminium or hylem wood bearing used to center the rotor with casing to avoid the fixation of original bearing while overhauling. Normally these are non lubricated.

198.What is honeycomb labyrinth?



The use of honeycomb labyrinths offers even better control of leakage rates (up to 60% reduction compared to straight pass type). It operates at approximately half of the radial clearance of conventional labyrinth seals. It consists of S.S. foil about 10 mills thick. Hexagonal shaped cell make are enforced structure that provides a larger number of effective throttling points. In addition S.S. honeycomb retains its strength at high temperature and pressure levels, which would cause weakening of an aluminium labyrinth.

199.What is head?

Head used to close either side of the barrel and house the bearing end gas seals and oil seals made of solid forging. Depending gas medium either carbon steel or stainless steel are selected.

200.What is head puller?

It is arrangement of mechanical tool used to pull up head from the barrel of compressor on its position.

201.What is bellyband?

It is a large steel clamp fabricated to hold the full assembly of rotor with diffuser and diaphragm housings with together for lifting and transporting the assembly safely.

202.Differentiate bundle 'o'ring & head 'o' ring?

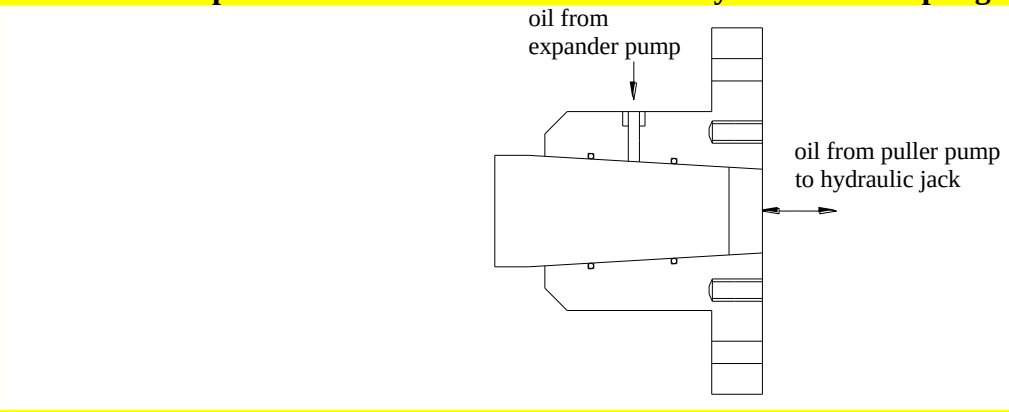
Bundle 'o' ring avoids the leakage between suction and discharge side of gas flow.

Head 'o'ring avoids the leakage of discharged pressure gas into atmosphere. This 'o'ring should be used with a back up Teflon ring to neglect extrusion due to high-pressure ratio.

203.What is hydraulic fit coupling?

The coupling can be fixed or removed in the shaft easily with hydraulic pressure by a separate hydraulic pump. This coupling has interference fit with shaft.

204.Draw a simple sketch to assemble & withdraw hydraulic fit coupling?



205.What is pusher pump & expander pump?

The pump connected in the jack to pull or push the coupling into shaft named as pusher pump.

The pump used to induce high hydraulic pressure between the contacting face of coupling and the shaft to make work easy named as expander pump.

206.Is hydraulic fit couplings with 'o' rings or with out 'o' rings?

With 'o' rings.

207.How do you ensure fit of taper coupling?

By the projection of the coupling face with the shaft end face. It is between 1/16 to 1/8 inches.

208.What is diaphragm coupling?

It is one of the flexible coupling used between compressor and steam turbine. All parts of this coupling are solidly bolted together, no moving or no wearing parts, therefore no lubrication is necessary.

209.What is active shim & store shim?

The shims connected on coupling with drive or driven hubs to transmit load with flexible named as active shims.

The extra shims bolted steady with coupling and these have not take the load of transmission named as store shims. It should be fixed for the consideration of dynamic balancing of the rotor and add or remove the shims in between the coupling depends span length.

210.What is shear plate coupling?

This coupling has the several of round plates with holes for bolting coupling spacer with hub intermediately and it has be sheared & failured in case of high torsion force of drive exceeds ultimate limit. It is simply known as metal flex coupling.

211.Name different types of coupling?

Rigid coupling; 1.Flanged coupling, 2.Muff coupling, 3.Threaded sleeve coupling, 4.Four piece coupling (in Gould's sump pump)

Flexible coupling; 1.Metal flex coupling, 2.Diaphragm coupling, 3.Gear coupling, 4.Grid coupling

212.What is the allowable vibration level as per API standard?

As per API 670; Vibration amplitude = root of (12,000 / RPM) mills per second.

213.Name few parts of a reciprocating compressor?

1. Cylinder
2. Piston
3. Valves
4. Cross head
5. Connecting rod
6. Crank shaft
7. Crank case

214.What is the applicable standard for reciprocating compressor?

API 618

215.What is top dead center? How do you measure it?

The end of transverse movement of the piston towards cylinder head is the top dead center of the reciprocating compressor. It is measured by keeping lead wire in the cylinder towards head end and rotating the compressor till the piston come back after compressing the lead wire. Now the top dead clearance is equal to the thickness of the lead wire.

216.Is there any means to increase TDC? How to do it?

TDC can be increased through;

1. Increase or decrease the thickness of the cylinder head gasket
2. Loose or tightening the piston rod in the cross head if threaded with piston rod locknut

217.What is bottom dead center? How do you measure it?

The end transverse movement of piston towards crankshaft end is the bottom dead center.

It is measured by keeping lead wire in the cylinder towards crank end and rotating the compressor till the piston come back after compressing the lead wire. Now the bottom dead clearance is equal to the thickness of the lead wire.

218.Why TDC is more than BDC?

For the consideration of thermal elongation of crank, connecting rod, piston rod towards the cylinder head side at working temperature.

219.What is rod deflection? How do you measure it? When will it increase?

It is the deflection of the piston rod from its trueness position while running.

Measuring: keeping two dial indicators on the piston rod with 90 degrees each of the recess in the distance piece of reciprocating compressor and measure the reading of indicator while rotating compressor. Deflection will increase due to

1. Accelerated wear and scuffing – piston to liner, piston rings, piston rod packings.
2. Broken rod
3. Damaged cross heads
4. Damaged pin bushings
5. Frame failure
6. Misaligned concentricity of cylinder bore with crank shaft.

220.Explain the overhauling steps for a reciprocating compressor?

Compressor made: **BROOM WADE** model: **BW 2D**

1. Disconnect all auxiliary lines like, discharge, air inlet, loader air, cooling lines
2. Decouple coupling to disconnect with driver and remove crankcase foundation bolts to transfer total unit to workshop for carrying overhaul
3. Remove the both suction valves with loader and discharge valves from head. Remove valve head.
4. Open all inspection doors provided and loose the nut connects cross head and piston rod and take out piston assembly with rod through head side. While removing care should be taken about piston rings falling.
5. Dismantle piston plates, piston rings, expander rings, wear band and rod.
6. Remove cylinder house with crankcase with distance piece. And disconnect distance piece dismantle wiper packings and gland.
7. Remove wrist pin and take out cross heads.
8. Dismantle connecting rod big end bearing cover and remove split big end bearing and take connecting rods outside.
9. Remove coupling hub and flywheel.
10. Remove lube oil pump connected with outboard of crankshaft and inboard cover
11. Remove main bearings of connecting rod top half and take out crank shaft outside
12. Remove bottom half of main bearings.
13. Now the complete dismantling has over. Perfect inspection of each and every parts to be done while and after dismantling of any damage, score, break, etc.
14. Better is changing new one instead of reconditioning damaged parts
15. Assembly is the reverse procedure of dismantling
16. When assembling the following factors should be considered are main bearing radial and thrust clearances, connecting rod big end bearing and small end pin clearance, web deflection, rod run out, wear band clearance, piston plate clearance with cylinder bore, bore surface finish, piston ring end and side clearances, piston end clearances, oil tubes condition, valve lift and passing, loader piston freeness action, wiper packing clearance, free rotation and alignment.
17.

221.What are the various clearances measured during overhauling of reciprocating compressor?

1. Piston end clearance, 2.Piston ring side clearance, 3.Piston ring end clearance, 4.Diametrical clearance between piston with cylinder/ liner, 5.Rider ring diametric clearance, 6.Web deflection, 7.Piston rod run out, 8.Connecting rod big & small end bearings clearance, 9.Crank shaft main bearing clearance, 10.Crank shaft thrust allowance, 11.Cross head with cross slide clearance, 11.Gas & oil wiper packings clearance

222.What is cylinder to piston clearance? How do you measure it?

It is the diametrical clearance of piston outer with cylinder or liner bore.

It can be measured by feeler gauge or micrometers.

223.How do you check piston ring end clearance?

By inserting the piston ring in to the cylinder bore and checking the clearance of the piston ring ends with the use of feeler gauge.

224.What is difference between piston ring & bearer ring?

Piston ring, which used to avoid leakage from the piston end compressed gas to outwards through piston circumference.

Rider or bearer ring used to guide the piston movement and neglect the scuffing of piston with cylinder liner when the piston rings are damaged. It has less clearance with the cylinder bore.

225.What is the MOC of piston ring & bearer ring?

1. Cast iron, 2.Carbon, 3.Bronze, 4.Teflon, 5.Phenolic

226.How much the normal clearance between piston ring to piston groove?

It simply specified as piston ring side clearance

For MOC of cast iron, bronze, carbon – 0.001 inches

For MOC of Teflon – 0.012 inches

227.Name different types of gas packing rings?

1. Pressure breaker ring
2. Radial cut ring
3. Tangential cut ring
4. Anti extrusion ring

228.What is pressure breaker ring? Where it is located? Which one is pressure breaker ring?

This is the simplest form of packing ring acts to break or slow down gas passage only with out actually sealing it completely. This prevents damage to packing rings and garter springs due to the shock effect of the differential pressure involved.

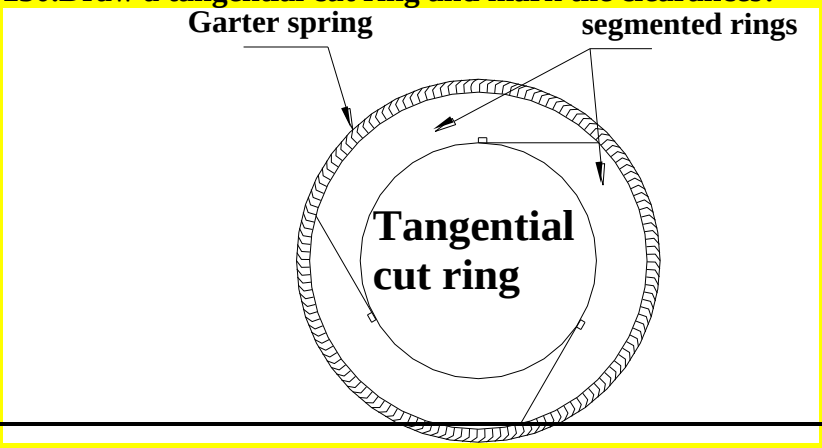
It has a limited clearance at the cut only and should not exceed more than 0.010 inches per inch of bore diameter. Obviously this ring should not be allowed to operate with out end clearance because its life would be very short. This ring located in prior towards gas side.

229.What is sealing ring? Where is it located? Which one is sealing ring?

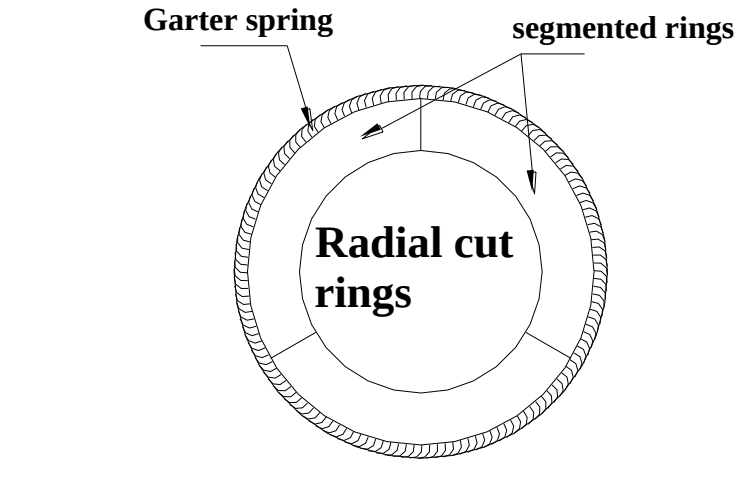
The true sealing ring made up of a pair of rings, the first of which is radially cut with considerable clearance at each end. The second ring is tangentially cut forming an overlapping seal joint that prevents gas passage from the outside periphery toward the rod bore. The inner radial cuts of this tangent ring are arranged so that they occur approx. between the radial cuts of the first ring in the pair. In this manner, gas passage along the rod is blocked so that there is no through escape.

This type of ring is single acting or directional in that it seals pressure from one side only.

230.Draw a tangential cut ring and mark the clearances?



231.Draw a radial cut ring and mark the clearances?



232.Is there any clearance between cup to packing? Why that clearance is given?

Yes. This clearance given for

1. Space for oil film lubrication
2. Shock effect of the differential pressure involved

233.What is the MOC of gas packing rings?

1. Tetra fluro ethylene, 2.Carbon, 3.Bronze, 4.Teflon, 5.Babbitt material, 6.Cast iron

234.What are various methods of capacity control?

1. Speed regulation, 2.Suction throttling, 3.Holding inlet valve open, 4.Clearance volume variation

235.What is clearance pocket?

Clearance pocket made up of a cylinder with a piston to regulate the capacity in high-power compressor by varying the clearance volume. It can be operated manually or by automatic means and divided into two types of

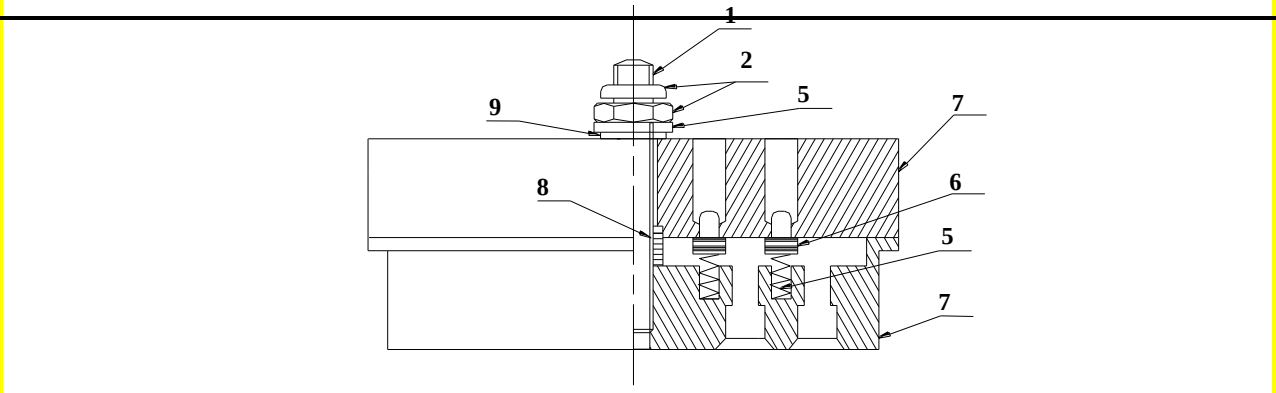
1. Constant clearance pocket
2. Variable clearance pocket.

When this pocket in operation the compressor neither draws in nor delivers any gas: both valves are closed and a constant amount of gas is expanded and compressed in the cylinder.

236.What is suction unloader?

It is a pneumatically operated piston-type device overcomes the tension of a spring and moves down the rod of the piston like element terminates in fork, the prongs of which will keep the inlet valve plate off the seat. As a result no gas will be compressed and delivered because the inlet valve will be open, and the will be pushed out of the cylinder into the intake line until the air pressure relived in the piston of unloader. Thus the compressor capacity is reduced by skipping the discharge strokes.

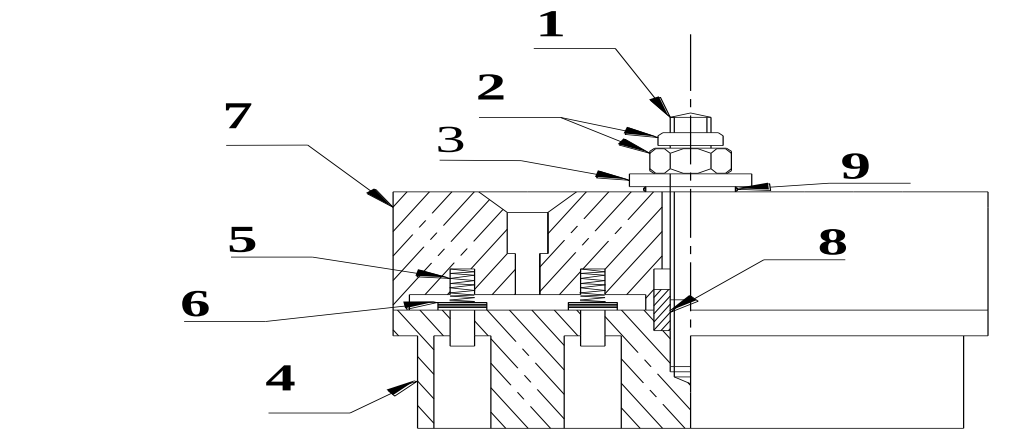
237.Draw a simple suction valve and name its parts?



1.valve stud 2.self locking nut 3.collar
4.valve seat plate 5.plate spring 6.valve
7.valve guard 8.centring sleeve 9. 'O'ring seal

]238.Draw a simple discharge valve and name its parts?

1.valve stud 2.self locking nut 3.collar
4.valve seat plate 5.plate spring 6.valve
7.valve gaurd 8.centring sleeve 9.O-ring seal



239.How do you recondition the valves of a reciprocating compressor?

The main work of reconditioning the valve is to make the seating area of plates in perfect appropriate level by lapping. Out of this well vision able inspection of valve plate, seat plate, lock screw and the condition of springs should be adapted.

240.How do you leak check a valves of a reciprocating compressor?

1. Liquid filled observe for 1.5 minutes and slots of seat must still be half full
2. Leak check by connecting to metered air supply system.

241.Second stage discharge pressure is high? What is the problem? How will you identify?

Causes

1. Inter cooler between second and third stage or after cooler has not effective cooling – feeling cooling water circulation
2. Unloader not working – check the unloader spindle position any marked
3. Second stage discharge valve not opened properly – feel temperature of valve
4. Improper piston end clearance
5. Third stage suction valve not opened – checking with stethoscope

242.There is a capacity reduction in the compressor? What is the problem?

1. Suction valve damage/passing

2. Discharge valve damage/passing
3. Clearance pocket may be in open condition
4. Unloader loaded
5. Damage piston rings or packing rings
6. Excessive piston end clearance
7. Speed less

243.There is a reduction in the discharge pressure of the compressor? What is the problem?

1. Suction valve damage/passing
2. Discharge valve damage/passing
3. Clearance pocket may be in open condition
4. Unloader loaded
5. Damage piston rings or packing rings
6. Excessive piston end clearance
7. Speed less

244.What is the normal pressure ratio of discharge to suction?

14: 1

245.Why intercoolers are used?

a. Remove heat of gas taken by compression
b. Reduce the volume of gas consistence to other stage
c. Save in power
d. Increase efficiency

246.What is distance piece?

This piece with inspection doors fixed in between compressor cylinder and the cross slide house. It accomplishes space for gas packings gland and wiper rings through inspection door. Drain line attached bottoms of it for identification incase of gas or oil leakage if any.
This can be aligned with cylinder or crankcase with measurement of rod deflection.

247.What is oil wiper packing?

Wiper packings fixed on the piston rod in the side of cross slide to avoid the leakage of oil outside and avoid the entry of gas into crosshead area incase of gas packing rings leakage. These packings are same like gas packing seal rings.

248.Why intermediate gas packings are used?

In the case of double acting compressor, compression takes place on the both side of piston. Front side of piston is sealed by covering cylinder head and the other side it can't possible because of the presence of piston rod. So a special type of sealing system used with the number of set of sealing rings. It is not a zero sealing system so purge gas to be provided behind of sealing ring sets to avoid the passing of hazardous compression gas out from cylinder. These sealing ring packings are called as intermediate gas packings.

249.What is cylinder jacket?

The jacket made with cylinder integrally or passage sealed with cylinder liner 'o' rings
For removing heat from gas by compression and friction heat of piston rings.

250.What is stuffing box jacket?

Cooling water circulated jacket provided in gas packing stuffing box for removing heat generated through the friction of packing rings with piston rod.

251.How the cooling water is prevented from entering the gas side?

With the use of 'o' rings on cups of stuffing box.

252.What is volumetric efficiency?

It is the ratio of the actual capacity of the compressor to displacement (swept volume) and is expressed as a percentage.

253.What is need for cylinder liner? What is its MOC?

Cylinder liner is used to avoid the change of cylinder or major recondition incase of high scuffing due to friction with damage or broken piston rings.

Liners are normally made of cast iron.

254.What is cylinder liner lubrication?

A force feed lubrication given to cylinder liner to minimize the friction with piston rings is called cylinder liner lubrication.

More lubrication causes the discharge valve plates to stick.

255.How do you lubricate the cylinder liner?

Force-feed lubrication by lubricator pumps given into the center of stroke length in the cylinder port provided.

256.Explain the procedure for liner removal?

Compressor made: **CLARK** model: **CRA, 40T**

1. Remove head, piston and piston rod
2. Remove stuffing box packing assembly
3. Take out cylinder from its position with distance piece
4. Keep cylinder in vertical position that the head side in bottom
5. Fix liner puller and pulling jack with a block loading the liner
6. Pull out liner downwards by hydraulic jacking
7. If the fitness is more steam jacketing in cylinder and dry ice in the liner should be carried for easy removal due to expansion of cylinder and contraction of liner while jacking.

257.What is single acting, double acting and balanced opposed?

Single acting: Compression of gas takes place in one side of the piston only.

Double acting: Compression of gas takes place on both sides of the piston.

Balanced opposed: Two set of piston and cylinder arrangement made in the single crank shaft horizontally 180 degree oppose for dynamic balancing and admit of rotative speeds higher than other types.

TURBINE

258.Name few parts of a steam turbine?

1. Casing
2. Running wheel
3. Nozzle
4. Labyrinth or carbon seal
5. Trip and throttle valve
6. Bearings

259.What is the applicable API standard for steam turbine?

260.Explain the overhauling steps for a steam turbine?

Turbine made: **TERRY** model: **Z-1**

1. Isolate steam inlet, remove coupling guard and coupling spacer to disconnect from driven
2. Dismantle governor and linkages with governor valve
3. Loose the bolts connecting top half split casing with bottom casing and take out.
4. Remove bearing covers on both side inboard and inboard
5. Remove leak-off lines of carbon ring housings
6. Take out rotor with stuffing box and transfer to workshop to carry further overhaul
7. Dismantle stuffing box case and carbon rings and journal bearings
8. Remove governor drive coupling, trip collar, ball bearing, steam bunters on outboard side
9. Remove coupling hub and steam bunters on inboard side
10. Loosen wheel lock nuts with noting proper position of wheel and remove the wheel from the shaft with the use of arbor press
11. Perfect inspection should be carried on each and every parts incase of any damage, score, brake
12. Assembly is the reverse procedures of dismantle. Use proper sealing compound in-between casing split and bearing housing cover.
13. The following factors should be considered while and after assembling are, shaft run out, nozzle and reversing chamber condition, governor valve and trip functioning, journal bearing radial clearance and crush, carbon ring clearance, governor function, free rotation, alignment, etc.
14. Trip check should be checked before coupled with driven.

261. What is regulating valve or governing valve or chest valve?

It is a special designed throttle valve used to control the flow of steam into turbine through open or close signal gotten from governor to maintain the speed of the turbine stable.

262.What is TTV or MSV?

TTV- Trip & Throttle valve is a combined valve of both trip shut off and throttle together construction. Trip valve is shut off when the speed of the turbine exceeds limit suddenly and the throttle valve controls the speed of the turbine as per speed set on governor. This valve is normally used in low or medium load turbines.

MSV- Main shut off valve is a trip valve used to cut off steam suddenly when speed or any abnormal condition of turbine exceeds except than throttling. The throttling or chest valve is separately fixed after MSV to maintain the speed. Normally this valve used in heavy load turbines.

263. What is nozzle box?

The blades form short arc nozzles they are mounted in a blade carrier ring which is secured to the casing called as nozzle box.

264. What is nozzle?

In impulse turbine the nozzles are fixed at the inlet end and steam passes through these converging nozzle passages, which reduce its pressure by increasing velocity progressively converting heat energy into kinetic energy.

265. What is fixed blade and moving blade?

Fixed blades are stationary blades fixed in the casing. Moving blades are fixed on the running wheel in the design of reaction turbine. The drop in pressure takes place in the fixed and moving blades, falling gradually through out the turbine.

266.Where to measure moving blade to fixed blade clearance?

In between the moving blades on the running wheel and the fixed blades of carrier ring, downstream side of steam flow in moving blades. This clearance measured after pulling rotor 'up stream'.

267.What are the various clearances measured in a rotor?

1. Labyrinth clearance
2. Carbon rings clearance
3. Bumping clearance
4. Bearing clearance

268.How do you assemble carbon packings? What is anti rotation pin?

The segmented carbon packing rings fixed on the rotor shaft hold by a garter spring with a less clearance about 0.001 inches in cold condition. The carbon rings are prevented from rotating by a tang or pin named as anti rotation pin. The thermal expansion of carbon is less than that of steel.

269.How do you center a turbine rotor?

The turbine rotor centered according bumping clearance between fixed and moving blades.
This can be achieved by add or remove shims behind the thrust collar.

270.What are the different types of labyrinth in a turbine rotor?

1. Conventional labyrinth seal, 2. Straight type labyrinth, 3.Stepped labyrinth, 4.Knife edge labyrinth, 5.J type labyrinth, 6.Turbine type labyrinth

271.How do you check bumping clearance?

By the use of feeler gauge.

272.What is internal casing?

It is a guide blade carrier and inserted with its circumferential groove in to a corresponding supporting web of the outer casing. The web is also used for axial positioning.

273.What is internal clearance? Why it is necessary? Explain the procedure?

Internal clearances between moving and guide are required for compensating thermal expansion and to provide running clearance.

Owing to a virtually symmetrically design of the inner casing, all its cross- sections show practically the same amount of expansions. Substantial thermal stresses in the inner casing needn't be expected, because its outer and inner walls are exposed to almost the same temperature.

274.Explain the procedure of carrying out optical alignment? What is its advantage?

Fix the laser transducer and the reflector frame with the use of chain type bracket. Connects the connecting cable between transducer and control unit, which consists LCD monitor, entering keys of dimensions of foot length of movable machine. Enter the foot lengths in the control unit. Little shaft rotation required determining alignment, obtaining accurate alignment results with as 60-degree shaft rotation.

Finding out the result is simple by the three key operation of 1. Enter dimension, 2. Rotate shafts, 3. Read results. Add or remove shims on front or and back feet of movable machine till achieving best alignment results.

Advantages: 1.easy operation, 2.accurate, 3.little shaft rotation is enough, 4.online measurement can take all these elements into account and yields accurate repeatable thermal growth.

275.What is a governor? Name few types?

Governor is a device, which senses the speed of turbine and controls the steam to the turbine to maintain the speed at a desired level to meet changes in load or steam flow.

Types:

1. Mechanical governor
2. Combined mechanical and hydraulic governor
3. Instrument governor
4. SG (simple governor)
5. TG (turbine governor), etc.

276.What is minimum and maximum governor speed of a governor?

The minimum and maximum speed set in a governor; in between of that speed only governor takes its control of the running machine to maintain speed constant.

To match the governor speed we would use speed step up or reduction gear mechanism in turbine of high speeds.

277.What is Woodward PGPL & SGX governors?

Both governors are controlled by pneumatic air pressure. PGPL used in high speed turbines with speed reduction gears. The actual speed of the governor is step down with the speed of the turbine.

SGX governors used in low speed turbines coupled directly with a flexible coupling.

278.Explain a problem faced by you in a governor & how did you overcome?

Problem- governor hunting

Overcome- changing new oil to full level

279.What is speed droop governor?

It is a governor with the facility of adjustable (variable) droop mechanism to run the machine at maximum droop with the difference load operational condition. Example- UG 8 woodward governor.

279.What is isochronous governor?

The governors are capable of operating at zero droop called as isochronous. An isochronous governor will maintain a constant speed up to 100% load. When an increase of load is placed on a turbine the actual speed will decrease temporarily. The governor will increase the steam to bring the turbine back to the original speed and carry the larger load. If a load is removed from a turbine, the speed will increase temporarily. The governor will decrease the steam to bring the turbine back to the original speed and carry the smaller load.

281.A governor is hunting? What are the on line & off line adjustments that can be tried?

On line: Changing new oil up to full level
Checking link freeness
Clearing linkage looseness if any
Setting valve travel correctly with governor linkage

Offline: Adjust speed droop
Checking worn out parts and correcting

282.What are the various trip systems available in a turbine?

Over speed
Low lube oil pressure
Rotor displacement
High lube oil temperature
High vibration

283.How do you check OST in a turbine? How do you adjust OST?

When checking OST in a turbine, which should be decoupled from the driven unit to avoid the pump to run in the speed more than normal design and it is dangerous act so.

Run the turbine until over speed by allowing more by pass steam out of governor control to check the action of over speed function properly.

If it is not proper trip need to adjust by increase or reduce the spring force of over speed weight through fastening adjusting screw to vary the desired over speed.

284.Why LLO trip is given for a turbine?

When the lube oil pressure comes down results the rapid damage of journal bearing due to insufficient lubrication and cause severe injure of equipment and environment. so for low lube oil trip should be given for a turbine. LLO trip actuate the latch cylinder of MSV to disconnect and the valve close suddenly to shut off the flow of steam. The turbine turns to idle trip position.

285.What is extraction cum condensing turbine?

From the outlet of steam from turbine, one part of steam is used for process operation with constant pressure and the other residual part of steam condensed by a condenser called as extraction cum condensing turbine.

286.What is the control mechanism for extraction cum condensing turbine?

Askania control mechanism.

287.What are the various parameters to be noted down for the above hydraulic circuit?

1. Speed control device
2. Pressure control system
3. Tripping device
4. Extraction control limit

288.What is gland ejector? What is ejector condenser?

Both ejectors are used in condensing turbine design which outlet pressure of steam is less than that of atmospheric.

Gland ejector is used in the gland area of the turbine for positive flow of leak off steam to atmospheric and to avoid the entry of atmospheric air into turbine.

Ejector condenser used in the surface condenser of turbine for sucking the steam from outlet, which pressure is less than atmospheric into the condenser.

289.What is hogging ejector? What is start up ejector?

Hogging ejector is a start up ejector to create the vacuum pressure in the outlet of turbine while starting up the turbine pertaining positive rotation.

290.What are the auxiliaries for a steam turbine?

Ejectors, Condensers, Orifice, Lube oil filters/ coolers, Overload steam nozzles, Traps, Governors, etc.

291.What is thrust collar?

It is a circular ring formed integral or fixed on the rotor shaft of the turbine. It is loaded on thrust bearings both side with a thrust clearance about 0.008 to 0.015 inches to take thrust load of rotor. Rectangularity and the surface roughness of thrust collar should be care when fixing.

292.How is tachometer drive taken from the rotor?

Through the 50 or 60 teeth gear fixed on the rotor when the current frequency of tachometer is 50Hz or 60Hz respectively. A proximity probe provided with a magnetic sensible gap to sense the tooth of gear rotation and converts into number of revolution by electrical signal and shows on monitor.

293.What is pedestal trip?

It is a hydraulic trip device used to shut off trip valve when the turbine reaches over speed.
When the over speed trip weight actuate the trigger of spring loaded piston to release from its position cause a sudden pressure reduction by connecting the latch cylinder pressure oil of trip valve to drain. The result of sudden latch disengages cause the trip valve to close immediately.

294.What is impulse and reaction turbine?

Impulse turbine: These are fitted with nozzles at the inlet end and steam passes through these converging nozzle passages, which reduce its pressure by increasing velocity progressively converting heat energy into kinetic energy. Impulse rotor blades inlet edges set at an angle of 15 and 30 degree to the direction of rotation. The steam then leaves the blades at a similar angle to that of its energy. In impulse turbines the entire drop in pressure takes place in fixed nozzles, the pressure through out the stages remaining constant. High pressure service and have little end thrust on the rotor. It has high vibration of wheels.

Reaction turbine: Pressure drops in gradual and takes place continuously over the fixed and moving blades. In fixed blades velocity increases, the pressure of the steam falls as it passes over the moving blades. The fixed blades correspond to nozzles, they change the direction of steam towards the moving blades, at the some time allow it to expand to a higher velocity. It is a simple, sturdy construction with less vibration and efficient in low-pressure service. Dummies require to reduce steam thrust on the end of the rotor. The fine blade tip clearances necessary are liable to cause stripping of the turbine.

295.What is static electricity?

It is a one method of generating electricity by the frictional contact of two dissimilar polarity elements, as the charge placed upon a glass rod by rubbing with silk or fur. It is the electricity at rest.

296.What is electrical run out?

297.What is gauss meter?

It is an instrument used to find out the density of magnetic flux.

298.What is pressure compounded & velocity compounded turbine?

Pressure compound: In which the steam pressure is dropped in number of stages of the turbine that is the total pressure drop does not take place in the first nozzle ring but divided up equally between all the nozzle rings. To minimize heavy end thrust when the steam exists high pressure on inlet side, dummy piston is used.

Velocity compound: The steam is expanded through the sets of nozzles to a high velocity and is then passed over the first moving blades. Only a portion of this high velocity is absorbed by this moving blade. The reminder being exhausted on to the next ring of fixed blades in the way of arc nozzles, which change the direction of the steam with out affecting velocity and the steam is passed on to the next ring of moving blade. This process repeated until the total velocity is absorbed. The steam flows through the blades, the pressure remains constant, so there is no large end thrust to be balanced as the steam thrust acts in a rotary direction only.

299.How do you demagnetize a rotor?

With the use of carbon slip ring brush

300.What is earth brush?

Through spring loaded carbon brushes which connected with earthing system properly

301.What is the compound used in the split half of the casing?

Coat of cement from 'copallite' and lay two threads of shoe maker's twine or asbestos yarn around the joint approximately ¼ inches apart.

302.What is the principle of bolt heater?

Removals of high torque tighten bolts through elongation of bolt by the induction of heat transfer with the use of bolt heater.

303.What is centrifuge? Why it is used?

It is a machine used to clarify and purify the lube or seal oil to maintain the quality (flash point) of oil with in control. It removes contaminated unwanted gas, air, liquid (water) and solids from the circulated oil in the system by the principle of centrifugal force.

304.What is the filtration size of normal LO filter?

25 microns.

FINFANS

305.What is finfan?

To cool the fluids through fined air-cooled tubes with intensity of positive flow of air from a fan called finfan.

306.What are the various measurements to be taken on finfan?

1. Blade angle
2. Tip track
3. Bearing thrust allowance
4. Fit of fan hub and sheaves with shaft
5. Alignment of belt drive

307.How do you measure blade angle? What is the instrument used? How do you adjust?

Measuring angle with the use of bevel protractor positioned on the blade one-inch distance from the tip of blade. Angle is adjusted by releasing blades free to rotate from hub.

308.How do you measure tip track?

Tip track is the difference in the same line of rotation in the tip of all blades.
It is measured by marking line the end of blade with frame.

309.What is FRP blade? What is its advantage?

FRP – Fiber Reinforced Plastic, coated on sheet metal formed fan blade.
Advantages – less weight, high strength of bending and low cost.

310.What are the various methods of fixing the blade to hub?

1. By hub split clip locking
2. Flanged bolted with slotted hole
3. Tensioned bolted with segmented lock rings

311.What are the various methods of drive arrangement available for finfan?

1. Direct couple with motor shaft
2. Belt drive

312.What are the PM jobs carried out on a finfan?

1. Periodic vibration measurement, 2.Lubrication of fan bearings, 3.Checking belt condition
4. Measuring any noisy operation

Absolute Pressure: The existing gauge pressure plus atmospheric pressure. At sea level the gauge pressure in pounds per square inch is 0 PSI. Adding 14.7 gives the absolute pressure in pounds per square inch (PSIA). This is a pressure measured from a base of absolute zero. We breathe air at a pressure of approximately 14.7 pounds per square inch absolute (psia). We don't notice this pressure because it is always around us and its called atmospheric pressure. However, if we look at an unused pressure gauge it reads 0 psi. The absolute pressure of a system therefore equals the sum of Atmospheric Pressure and Gauge Pressure. See PSIG.

Absolute Temperature: The temperature of a body referred to the absolute zero, at which point the volume of an ideal gas is theoretically zero. (absolute zero = - 459.67°F / - 273.15°C).

Activated Alumina : An adsorption type of desiccant used in some desiccant dryers.

Adiabatic Compression: A type of compression where no energy transfer as heat is transferred to or from the gas during the compression process.

Adsorption: The accumulation of gasses, liquids or solutes on the surface of a solid or liquid. This term is often used when describing the action of desiccant dryers. Not to be confused with "absorption".

Adsorbent Filter: A filter medium primarily intended to hold soluble and insoluble contaminants on its surface by molecular adhesion.

Air Plant Capacity: "Standard Cubic Foot," or its abbreviation "SCF," used as a measure of Compressed Air means that quantity of dry air (0% RH) which in gaseous form would occupy a volume of one cubic foot at 60 degrees Fahrenheit temperature and 14.70 pounds per square inch absolute pressure. One thousand SCF shall be abbreviated herein as "MCF".

Air Receivers : Steel tanks in to which the compressed air or gas is discharged from the compressor. Receivers help to eliminate pulsation in the discharge line (for reciprocating compressors) and also act as storage capacity during intervals when the demand exceeds the capacity of the compressor. Use proper size tank as furnished and/or recommended by manufacturer. Do not reduce tank size or restrict discharge air line from compressor tanks.

Aftercoolers: Heat exchangers that remove the heat of compression of the air or gas after compression is completed. They are also one of the most effective means of removing moisture from compressed air. Compressed air normally contains some moisture which can cause damage to air devices. Aftercoolers, which assist in removing this moisture by lowering the temperature of the air, can be either of the water-cooled or the air-cooled type.

ANR: Atmosphere normale de reference. The term ANR is not usually applied to cfm, it is the new European replacement for Free Air Delivered (FAD) and usually follows the metric measurement of air flow, such as Cu Meters per Minute ANR.

Asset Monetization: When a company like an energy service provider builds, buys, owns, maintains and operates your existing energy systems or equipment.

Axial Compressor: An aerodynamic machine, usually multistage. The air is drawn through a series of rotors (propeller like) and stators until the desired working pressure is achieved. It is called axial because the air essentially enters one end of the compressor and is ejected at pressure from the other end. This type of compressor is usually applied to very high capacity compressed air requirements.

Bar: A unit of pressure equal to 1,000,000 Dynes / cm2 , 0.99 atmospheres. A measurement of pressure, 100kPa = 1 bar. This corresponds very closely to 1 atmosphere and the two are often confused. 1 bar = 14.504 psi. 1 atmosphere = 14.7 psi.

Barometric pressure: Is the absolute atmospheric pressure existing at any given point in the atmosphere. It is the weight of a unit column of gas directly above the point of measurement. It varies with altitude, moisture and weather conditions.

Base Air Requirement (BAR): The quantity of compressed required by the customer to meet normal system demand as defined in Standard Cubic Feet per Minute (SCFM). The BAR is established to cover the maximum requirement of the customer during the normal production cycle.

Base Monthly Facility Fee: The "Base Monthly Facility Fee" is a fixed monthly charge to supply the Base Air Requirement.

Bernoulli's Principle: In physics, the concept that as the speed of a moving fluid (liquid or gas) increases, the pressure within that fluid decreases. Originally formulated in 1738 by the Swiss mathematician and physicist Daniel Bernoulli, it states that the total energy in a steadily flowing fluid system is a constant along the flow path. An increase in the fluid's speed must therefore be matched by a decrease in its pressure.

Bernoulli's principle applies in nozzles, where flow accelerates and pressure drops as the tube diameter is reduced. It is also the principle behind orifice or Venturi flow meters. These meters measure the pressure difference between a low-speed fluid in an approach pipe and the high-speed fluid at the smaller orifice diameter to determine flow velocities and thus to meter the flow rate. Bernoulli's principle is sometimes mistakenly used to explain the net force in a system that includes a moving fluid, such as lift on an airplane wing, thrust of a ship's propeller, or drifting of a spinning baseball. The principle, however, only applies to systems that do not produce a net force.

Blower: A compression device that is designed to discharge at lower pressures. Usually a blower discharges below ratios, although this figure can vary based on manufacturer.

Booster Compressors: Machines for compressing air or gas from an initial pressure, which is above atmospheric pressure, to a still higher pressure.

Boyle's Law: States that the volume of a gas, held at a constant temperature, will vary inversely with the pressure.

Brake Horsepower: The actual or useful horsepower of an engine, usually determined from the force exerted on a friction brake or dynameter connected to the drive shaft.

Breathing Air: Be careful with this! Not all compressor systems can produce breathing quality air. The compressed air requires special treatment to meet OSHA Grade D breathing air requirements. Leave the supply of breathing air to experts.

British Thermal Unit (BTU): The quantity of heat required to raise the temperature of one pound of water from 60° F to 61°F at a constant pressure of one atmosphere.

Bypass Valve: An automatic or manual valve that causes the flow to be vented. In centrifugal compressor applications this valve is also referred to as a blow-off valve.

Celsius (°C): Also known as the centigrade scale. The international temperature scale where water freezes at 0 (degrees) and boils at 100 (degrees).

Clean Room: An enclosure in which air characteristics such as temperature, humidity, contamination and pressure are maintained at a specific level.

Clean Pressure Drop: The pressure drop across a filter element as measured under steady state flow conditions using a clean test fluid across a clean filter element. This is not necessarily the pressure drop that will be realized by a clean filter in an actual operating condition. Clean, wetted pressure drop should be specified to better understand the actual operating characteristic.

Closed Loop System: A cooling system used with the CDA AIR Stations. The system in which a glycol/water and corrosion inhibitors are circulated through a air to coolant heat exchanger and storage tank in a closed loop. Heat picked up from the compressors by circulating fluid is transferred to the atmosphere through the heat exchangers.

Closed Loop Evaporative System: The same as the closed loop cooling system with the addition of spray bars. During periods of high ambient temperature, water is sprayed on the air to coolant heat exchanger. Evaporative cooling increases the heat exchanger's effectiveness, reducing the temperature of the coolant returned to the compressor.

Cogeneration : (1) Any of several processes that either use waste heat produced by electricity generation to satisfy thermal needs, or process waste heat to electricity, or produce mechanical energy. (2) The use of a single prime fuel source in a reciprocating engine or gas turbine to generate both electrical and thermal energy to optimize fuel efficiency. The dominant demand for energy may be either electrical or thermal. Usually it is thermal with excess electrical energy, if any, being transmitted into the local power supply lines.

Competitive Transition Charge (CTC): A non-by-passable charge representing the transition cost assessed to recover the reasonable uneconomic portion of the costs associated with (1) fixed costs from generation units, (2) costs associated with existing purchase power commitments and contracts, (3) unrecovered regulatory assets, (4) nuclear decommissioning expenses. CTC allows customers to take service from competitive suppliers who will provide commodity service over existing utility facilities in the deregulated state. CTC will be reduced over time as the generation and power supply contracts are sold and the profit from these sales is passed on to the ratepayers.

Compressors: Machines designed for compressing air or gas from an initial intake pressure to a higher discharge pressure.

Compressed Air: Air that has been pressed into a volume smaller than it normally occupies. As compressed air exerts pressure, it has stored potential energy. The compressed air performs work when released and allowed to expand to its normal free state.

Compressor Module: Also referred to as an AIR Station Module, a "Compressor Module" is a complete, prefabricated compressor system. The components of a complete Compressor Module are inlet filter, compressor, after cooler, prefilter, air dryer, after filter and associated subsystems. The Compressor Module is prefabricated and delivered to the customer's site. Several Modules are assembled together to create an AIR Station.

Compressor Station: "Compressor Station" means the facility to be installed, owned and operated by Seller for the compression, drying, delivery and metering of Compressed Air. The CDA product is referred to as an AIR Station

Compressor Station Site: "Compressor Station Site" means the plot of land or building to be furnished by the Buyer, subject to Seller's approval, for the Compressor Station. The Compressor Station site, location and boundaries will be defined as part of the final contract execution.

Condensate: The liquid that forms when compressed air is cooled, or when air is compressed at constant temperature. The condensate produced by compressed air is water, although it may be contaminated with oil, dirt or other materials present in the incoming air.

Coriolis Force: An apparent force used mathematically to describe motion, as of air, relative to a non inertial uniformly moving frame of reference.

Central Operation Management System (COMSYS): "COMSYS" is the group of systems that allow CDA to maintain a telepresence in the compressor system. Using COMSYS CDA can continuously monitor and control the Compressor Station.

CENTRY™ Control Panels: The family of control panels developed and marketed by Clean Dry Air, Inc. The CENTRYPCS (Plant Control System) and CENTRYCLC (Compressor Level Controller) are used in the CDA AIR Stations.

Check Valve: In an air system, a valve that permits air flow in one direction only.

Compressed Air Distributing System: "Compressed Air Distributing System" means the system of trunk and service pipelines now or hereafter constructed, owned, or operated and maintained by Buyer and used to transport Compressed Air from the Compressor Station to the various use points within the facilities owned or operated by Buyer.

Dalton's Law: States that the total pressure is equal to the sum of the partial pressures for a mixture of independent substances (the constituent gases). The partial pressure is the pressure each constituent gas would exert if it alone occupied the volume of the mixture.

Delivery Date: The "Delivery Date" is the date that CDA offers the Base Air Requirement for delivery to the Buyer from the "Compressor Station" within the flow parameters detailed in this proposal.

Delivery Point: The "Delivery Point" is the connection between the Compressed Air Distributing System and the Compressor Station. Each party shall supply a flange to mate with the other's connecting flange on all piping connections. The locations of such flanges shall be considered the delivery point (the "Delivery Point"). Unless otherwise agreed to, it is the buyer's responsibility to connect from the compressor station Delivery Point to their Compressed Air Distributing System.

Deliquescent Dryers: A dryer which employs a chemical in the form of a tablet to absorb moisture. The chemical degrades into a liquid which is drained off periodically. Similarly the dryer has to be 'topped up' with new tablets to continue working.

Demand: The flow of air required to satisfy usage at specified temperature and pressure conditions.
Demand Controller. Sometimes also called a "demand expander". We have to be politically correct when discussing these devices. There are users of these devices that claim great reductions in energy costs. We just have not been able to understand the fluid dynamic principles that support the theory of operation. We believe they may be successful in lowering the demand side pressure which in turn would cause the leaks to "leak less". Of course you always want to minimize the production side system pressure so there is still a disconnect.

This is a device that is placed within the air system. It is sold on the basis that they maintain constant system pressure. We can see some benefit in applications where non-modulating (on-line/off-line control) compressors are applied. Be careful if the device you are considering requires storage capacity that is maintained at pressures higher than actual system pressure or point of use requirements . On a fundamental level this is inefficient. CDA neither recommends nor not recommends these devices.

Deregulation: Deregulation splits off two lines of the power business that have been controlled by regulated monopoly utilities. It allows new players to compete in providing electric services setting their own prices rather than negotiating with state regulators on a fixed rate.

Desiccant: A substance such as calcium oxide or silica gel that has high affinity for water and it is used as a drying agent.

Dew Point: Error! Hyperlink reference not valid. to a discussion of Dew Point
Diffuser: An item within an aerodynamic compressor which converts the velocity head into a static head. The diffuser usually consists of a set of vanes at specific angles so that the discharged air is efficiently slowed down.

Discharge Pressure: The actual pressure that is available from the air compressor. This is not the same as the system pressure or the required pressure. It is important to ensure that a new compressor has a discharge pressure which is great enough to overcome losses through pipes and any air treatment, so that it can meet the required system pressure.

Dryer: A device designed to minimize water in compressed air systems. Several types are available, refrigerated, desiccant.

Electric Power Grid: A complex infrastructure of electric power lines and substations that support the delivery of electricity generated by linked power plants.

Electronic Data Interchange (EDI): Electronic exchange of data for customer enrollment, billing data exchange, termination of service, etc.

Energy Savings Performance Contracting (ESPC): ESPC is a method of reducing energy use and costs at no capital cost to the company. Under an ESPC, an energy services company (ESCO) pays all costs involved in identifying, installing, operating and maintaining the energy-efficient equipment and improvements. The ESCO is compensated by receiving a share of the cost savings resulting from these improvements. At the end of the contract (which can extend to 25 years) the company owns all the improvements and receives all of the continuing savings.

Fahrenheit (°F): The international temperature scale where water freezes at 32 (degrees) and boils at 212 (degrees).

Federal Energy Regulatory Commission (FERC): The agency that monitors sales of electricity across state lines and regulates the use of transmission lines for such sales.

Firm Capacity Plant: A "Firm Capacity" plant is one in which all the major components in the plant are backed up. For example, in a CDA Compressor Station that requires two modules to meet the contract requirement a complete third module would be installed to meet the classification of Firm. A Firm Capacity plant requires significantly more capital investment on the part of CDA. The customer should specify a Firm Capacity plant when they cannot tolerate any reduction in the delivered compressed air capacity due to machine maintenance or failure.

Fouling: Accumulation of foreign matter, such as mud or debris, in a cooler, pipe, or valve. In a cooler, H2O DP and DT will be seen to increase, as well as CTD (.H2O T in to Air T out)

Free Air Delivered (FAD): Air at normal atmospheric conditions. Be careful, since the altitude (barometer) and temperature vary at different localities and at different times, it follows that this term does not mean air under identical conditions. It is much more desirable to define SCFM and specify the required capacity.

Gas and Mechanical Horsepower: The total brake horsepower consumed by a compressor is made up of two components. First, the gas horsepower which is only the power required to compress the air. Second, the mechanical horsepower, which is the power consumed by compressor itself. Mechanical horsepower is sometimes referred to as parasitic loss, it is the power consumed by the gear train or running gear.

Hot Start: The compressor is started automatically, depending on demand. Control panel is energized with no "pre-start" cycle required, as pre-lubrication pump and buffer (seal) air are always "on". A state of pre-start exists. Steam turbine compressors are "slow-rolling" to maintain "pre-start" turbine temperatures at an adequate, recommended level. A higher level of instrumentation and monitoring accessories are recommended when Hot Starting.

Incremental Air Fee: The "Incremental Air Fee" is the charge for compressed air consumed above the BAR and is charged based on the quantity consumed.

Incremental Air Requirement (IAR): The quantity of air required in excess of the Base Air Requirement. Air compressors are designed as frame sizes. Each frame size will deliver up to a certain amount of flow. Many times the air requirement of a customer will fall in the middle to bottom of a compressor frame. This creates additional available capacity from the compressor or AIR Station. This additional capacity may not be utilize initially, but is available, usually at a reduced rate, to the customer in the future. Incremental air capacity can be intentionally built into the AIR Station, but this usually results in additional capital cost which is reflected in the facility fee.

Independent System Operator (ISO): A regulatory body responsible for the operation and control of the statewide transmission grid. ISO ensures efficient use and reliable operation of the transmission grid consistent with fulfillment of rigorous planning and operative reserve criteria. ISO adopts inspection, maintenance, and repair and replacement standards of transmission facilities under its control as well as standards for safety and reliability during periods of emergency and disaster. It also participates in all relevant Federal Regulatory Commission proceedings.

Inlet Filter: Specified and applied to assure that the air entering the compressor is free of foreign matter. Many types of inlet filters are available. It is important to the long life of a compressor that the correct inlet filter is selected.

Intercoolers: Heat exchangers for removing the heat of compression of the air or gas between consecutive stages of multistage compressors.

Interruptible Capacity Plant: An "Interruptible Capacity" plant does not have an installed spare and can suffer decreases in delivered capacity. An Interruptible Capacity plant is designed to accommodate rapid hookup of rental air compressors to minimize capacity reductions. This type of plant requires a lower capital investment, which is reflected in a lower facility fee.

Investment Grade Site Survey: Once a customer indicates their intent to enter into an air contract with CDA , we will conduct an investment grade site survey. This is a detailed review of the station site and all aspects of installing and starting the air station. The Survey may include soil samples and review of potential underground obstructions. During the Survey the various air station interfaces to the customer's plant will be defined.

Kelvin: A unit of absolute temperature equal to 1/273 of the absolute temperature of the triple point of water. In Kelvin, absolute zero (absence of heat) is - 273.16 °K.

Kilowatt Hour (kWh): Unit of measure equal to 1,000 watts used continuously for one hour.

Knock Out: A term used to describe the condensate flow rate. It can be expressed as gallons per minute (GPM) or pounds mass per minute (lb_m/min)

Line Filter: Installed in the compressed air line, line filters are designed to trap entrained foreign matter harmful to pneumatic tools, equipment and instrumentation.

Load Shape: The variation in the magnitude of the power or compressed air load over a daily, weekly or annual period.

Local Service Provider: CDA is not a compressor service company. Whereas CDA does have extensive experience in compressor service it is not a product normally offered by the Company. Instead CDA works with the existing compressor service infrastructure as local service providers.

Mach Number: The ratio of the actual velocity at a given point to the velocity of sound in the same gas at the conditions existing at this point. These are known as local conditions.

Maximum Instantaneous Compressed Air Delivery Rate: The Base Air Requirement plus the Incremental Air Requirement. This is the maximum capacity available from the *AIR* Station with all compressors running and fully loaded.

MAWP: The Maximum Allowable Working Pressure. This data should be found on the pressure vessel nameplate. It represents the maximum pressure at which the vessel may operate. The lowest set safety valve should be set at the MAWP.

Maximum Operating Pressure: This is different than MAWP. This is the highest operating pressure the system or component is designed to withstand.

Moisture separators: Devices for collecting and removing moisture precipitated from the air or gas during the process of cooling. Moisture separators are designed to trap and expel, automatically or manually, any oil or condensed moisture which develops in a compressed air system.

Multi-stage Compressors: Also called compound compressors, they are those in which compression from initial to final pressure is completed in two or more distinct steps or stages.

N cu m/min (also N cu m/hr): Volume flow rate measured in normal cubic meters per minute (or hour), i.e. related back to normal inlet conditions.

NTP: Normal Temperature and Pressure. This is based upon a temperature of 32 deg F (0 deg C) and a pressure of 1 bara.

Nozzle: A projecting part with an opening, as at the end of a hose, for regulating and directing a flow of fluid.

Oil-free: The term generally applies to the condition of the air either when it leaves the compressor, or after filtration. An oil-free compressor will have no lubrication on the compression side of the machine. However this may not result in oil-free compressed air, simply due to the fact that the ambient air being sucked into the compressor will contain hydrocarbons which will condense into liquid oil further down stream.

Oil-less: A term applied to compressors that contain no oil. A small reciprocating compressor with PTFE piston rings and PTFE bearer rings, sealed for life bearings and no sump oil would be called an oil-less compressor.

Package Power: The total power absorbed by a compressor, including the power absorbed by all pumps, fans, coolers and the like. This is the figure to look for when buying a compressor.

Pascal: SI unit of pressure equal to one Newton per square meter. 1 Pa is a very small unit of pressure. For this reason kPa (1000 Pascal's) is more often used. 1 psi = 6.8948 kPa.

Piston Displacement of a Compressor Cylinder: The volume swept through by the piston. This is expressed as a rate, such as cubic feet per minute. The piston displacement of a multi-stage reciprocating compressor is that of the first stage only, since the same gas passes through all stages in series.

Pneumatic: Of relating to air other gasses. Run by or using compressed air: *a pneumatic drill*. Fill with air, especially compressed air: *a pneumatic tire*.

Portable Compressors: Used in the construction industry or as emergency compressed air backup, portables consist of a compressor and driver mounted that they may be readily moved as a unit.

Positive Displacement: This describes reciprocating, rotary lobe, rotary vane and screw type compressors. This type of compressor does not 'stall' and potentially can reach pressures well in excess of the design pressure.

Pressure Dew Point: In some sales leaflets this is referred to as PDP. The PDP is the temperature at which water will condense out of the *pressurized* compressed air. Two components define pressure dew point, the dew point temperature at a specified line pressure.

Pressure Swing Dryer: A desiccant dryer either heat less or heat reactivated.

PSIA: Pounds per square inch, absolute. This is the pressure of a system measured from absolute zero. It is exactly 1 atmosphere more than PSIG.

PSIG: Pounds per square inch, gauge. This is the pressure of a system which you would see displayed on a normal pressure gauge. It is the pressure of the system, over and above atmospheric pressure.

Rankine: A scale of absolute temperature using Fahrenheit degrees in which the freezing point of water is 491.69° R and the boiling point of water is 671.69° R.

Reciprocating Compressors: Those in which each compressing element consists of a piston moving back and forth in a cylinder. Classified as a positive displacement compressor. Single acting reciprocating compressors are those in which compression takes place on but one stroke per revolution in each compressing element. Double acting compressors are those in which compression takes place on both strokes per revolution in each compressing element.

Receiver: The vessel used to contain compressed air. As a general rule of thumb most systems need a minimum of a 'one minute receiver'. Although wholly inaccurate, the following will provide the basis of most systems. 700 cfm compressor at 7 barg. 700/7 = 100 cubic ft receiver. 700 cfm compressor at 10 barg. 700/10 = 70 cubic ft receiver.

Relative Humidity: The ratio of the partial pressure of the water vapor to the saturation pressure at the air temperature.

Reynolds Number (Re): Represents the ratio of inertia to viscous force. At low Re the viscous effects dominate and the flow is laminar. At high Re the inertial forces dominate leading to turbulent flow.

Safety Valves: Pressure limiting devices used on all air receivers built to code. They limit pressure to the maximum working pressure allowable. Safety valves are also installed in air lines between the compressor discharge and receiver when a equipment shut-off valve is present. Don't take the operation of your safety valves for granted. Compressed air has and will kill! Have your system and safety valves inspected by a compressed air specialist.

Saturation: The condition in which air at a specific temperature contains all the water vapor it can hold; 100% relative humidity. Occurs when the vapor is at the dew point or saturation temperature corresponding to its partial pressure. A gas in never saturated with a vapor. However, the space occupied jointly by the gas and vapor may be saturated.

Scaling. Build-up of foreign matter on the interior (H_2O) surface of coolers and pipe. Often caused by the precipitating-out of calcium carbonates due to high temperatures at the "hot" end of a cooler. With a cooler, seen as an increase of CTD (high air temperature) and lower temperature rise. Unfiltered, untreated, and oxygenated water are the most frequent causes in pipe.

Separator: The term used to describe the filter inside an oil injected screw compressor which removes the hot oil from the hot compressed air. The separator element is a consumable component which traps oil (and dirt) particles down to 1 micron. This means that a separator element may last for years in a clean factory and only months in a dusty factory.

S.I.: System International. The international system of unit measurement.

Site Survey: Before CDA can finalize a Contract *AIR*™ proposal, a site survey must be completed. A Site Survey Form is used to gather needed information on plant layout, the station site, etc. The time required to complete the survey can be greatly reduced if the customer begins to gather the information prior to CDA arriving onsite. Click the Information button on the side of this page to request a survey form.

Slippage: This refers to the compressed air lost due to in-efficiency in the design of the compressor. In a reciprocating compressor, some of the air will seep back past the gaps in the piston rings. In a screw compressor, some air will slip back through the small gaps which exist between the screw compressor rotors. This loss is called slippage.

Snifting Valve: This is a safety relief valve which works backwards and is used in vacuum systems. Instead of venting compressed air out of the system like a normal safety relief valve, it lifts at a pre-set vacuum to allow air into the system thereby protecting the vacuum pump.

Specific Gravity: The ratio of the mass of a solid or liquid to the mass of an equal volume of distilled water at 4° C (39 °F) or of a gas to an equal volume of air or hydrogen under prescribed conditions of temperature and pressure.

Specific Humidity: The ratio of the mass of water vapor to the mass of air in the mixture.

Specific Power Consumption: A quick and easy way of comparing compressor efficiencies, as long as you have exactly the right information before you start. The total package power is divided by the actual volume delivered at a specified pressure. It is usually expressed as " X " HP per 100 cfm. Some people turn this figure around and quote X CFM per HP, or X Cu Meters/hour per kW.

Stack Up: The interaction between the stages of a centrifugal compressor. When a multi-stage compressor is designed, each stage can operate at only one point its characteristic curve. The point is determine by the design conditions of temperature, flow and pressure. As the design conditions change the point on the stage characteristic curve will shift. The interaction of each stage curve is referred to as the "stack up" of the compressor.

Stall: In a centrifugal compressor stage stall is mild form of surge. It is the flow at which the stage is no longer making any ratio, but has not surged. The flow actually becomes detached from the tips of the impeller rendering it ineffective. Stall can be heard as a rumbling in the discharge pipe. Running for extended periods of time in stall can cause a impeller blade failure due to vibration and fatigue.

Static Head: This is indicated by a pressure gauge on a pipe or system. It is not necessarily the total pressure of the system, particularly if the velocities are high. See velocity head.

Stonewall: Sometimes called choke, it the point at the opposite end of the centrifugal characteristic from the natural surge point. Stonewall is the maximum flow that can be passed through a centrifugal compressor impeller.

Swept Volume: Watch out for this one! This term is mainly used by companies selling small compressors because it makes their compressors look bigger than they really are. The swept volume is the actual displacement of the piston, forgetting such losses as bumping clearances, valve clearances, ring losses and the like. If a compressor is rated for a delivery of 15 cfm, *swept*, be prepared to actually get about 10 Scfm delivered.

Telepresence: *Being there without being there.* The main idea of ubiquitous telepresence (**UT**) is to allow CDA experts to project their physical presence anywhere on the Internet. Specifically, CDA experts are given the ability to explore and interact with many remote systems (e.g., all sites on COMSYS) through remote sensing and observation devices.

Torr: A unit of pressure used with vacuum pumps, equal to 1mm of mercury and 133.32 Pascal's.

Turbine: A rotary engine that converts the energy of a moving stream of water, steam, or gas into mechanical energy. The basic element in a turbine is a wheel or rotor with paddles, propellers, blades, or buckets arranged on its circumference in such a fashion that the moving fluid exerts a tangential force that turns the wheel and imparts energy to it. This mechanical energy is then transferred through a drive shaft to operate a machine, compressor, electric generator, or propeller. Turbines are classified as hydraulic, or water, turbines, steam turbines, or gas turbines. Today turbine-powered generators produce most of the world's electrical energy. Windmills that generate electricity are known as wind turbines

Vacuum Pumps: Machines for compressing air or gas from an initial pressure which is below atmospheric to a final pressure which is near atmospheric. Absolute vacuum is a theoretical void in which no particles exist. However, even outer space contains pressure, 10**(-19) torr. A vacuum pump is a machine which sucks in air from a closed or restricted space. The harder it works, the closer it gets to absolute vacuum. The air delivered from a vacuum pump is called 'aspired air'.

Velocity Head: This is best explained by analogy, imagine a fireman's hose. The pumps are delivering water through the hose at 100 psig, however you can easily cup your hands around the water jet. Stand in front of the jet and you end up on your back. The pressure from the hose is almost entirely velocity pressure which is the same as velocity head.

Venturi: A short tube with a constricted throat used to determine fluid pressures and velocities by measurement of differential pressures generated at the throat as a fluid traverses the tube.

Volumetric Efficiency: In positive displacement compressors it is the ratio of the actual capacity of the compressor to displacement and is expressed in per cent.

Vortex: A spiral motion of fluid within a limited area, especially a whirling mass of water or air that sucks everything near it towards its center.

Wet Bulb Temperature: Is used in psychrometrics and is the temperature recorded by a thermometer whose bulb has been covered with a wetted wick. A sling psychrometer has both a wet and a dry bulb thermometer mounted on a common swing handle. The psychrometer is whirled around, providing the necessary air flow over the wet bulb. The wet and dry bulb readings permit the determination of relative humidity of the atmosphere. Some psychrometric calculations can be performed using the psychrometric calculator.

Newton's Law

Newton's first law states *a body at rest will remain at rest, or a body in motion will continue in straight-line motion unless subjected to an external applied force*. That means, if one sees a bend in the flow of air, or if air originally at rest is accelerated into motion, there is a force acting on it. Newton's third law states that *for every action there is an equal and opposite reaction*.
Newton's second law that relates the acceleration of an object to its mass and to the force on it; F=ma)

What is the surface finish of seal faces?
Silicon / tungsten carbide 0.05 micrometers C.L.A
Alumina ceramic 0.30 micrometers C.L.A
Satellite or other metals 0.12 micrometers C.L.A
Carbon 0.25 micrometers CL.A

What is the flatness of seal faces?
Up to 75mm diameter 2 light bands (0.0006 mm)
Over 75 mm diameter 3 light bands (0.0009 mm)

What are the recommended tolerances for a mechanical seal?
Shaft diameter in seal area : nominal size +0.00/-0.05 mm
Shaft finish in seal area : 0.8 micrometers C.L.A
Shaft end play : 0.1 maximum

Shaft run out in seal area:

Size	25 mm	50 mm	75 mm	100 mm
Tolerance	0.03	0.05	0.08	0.10

(Full indicator movement)

Square ness of shaft to stuffing box face:

Size	25 mm	50 mm	75 mm	100 mm
Tolerance	0.05	0.05	0.08	0.10

(Full indicator movement)
Concentricity of sleeve and box bore:

Size	25 mm	50 mm	75 mm	100 mm
Tolerance	0.05	0.08	0.1	0.13

(Full indicator movement)