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CHAPTER

Fluid Mechanics

Hydraulic Pumps

Q.1 A pump running at 1414 rpm delivers 256 lps of water against a head of 16 m. The pump is of the
(a) normal speed radial type
(b) double suction type
(c) mixed flow type
(d) axial flow type

Q.2 Two geometrically similar pumps are running at the same speed of 1000 rpm and lifting water against the heads of 25 m and 16 m respectively. First pump is having an impeller diameter of 300 mm. The impeller diameter of second pump shall be
(a) 192 mm (b) 240 mm
(c) 300 mm (d) 469 mm

Q.3 Which one of the following statements is correct?
(a) Reciprocating pumps are less efficient than centrifugal pumps.
(b) Delivery from a reciprocating pump is pulsating.
(c) Reciprocating pumps are suitable for large discharges and smaller heads.
(d) For a negative slip to occur, a reciprocating pump must have a coefficient of discharge less than unity.

Q.4 A high efficiency pump is required for low discharge, high head and low maintenance cost. Delivery of water need not be continuous. The pump need not run at high speed. Which one of the following is the correct choice?
(a) Centrifugal pump
(b) Reciprocating pump
(c) Air lift pump
(d) Hydraulic ram

Q.5 Which one of the following statement is correct?
(a) Pumps operating in series boost the discharge whereas pumps operating in parallel boost the head.
(b) Pumps operating in parallel boost the discharge whereas pumps operating in series boost the head.
(c) In both the above cases there would be a boost in discharge only.
(d) In both the above cases there would be a boost in head only.

Q.6 The function of an air vessel in a reciprocating pump is to obtain
(a) reduction of suction head
(b) rise in delivery head
(c) continuous supply of water at uniform rate
(d) increase in supply of water

Q.7 Cavitation parameter σ is defined in terms of NPSH (net positive suction head) and net head H as, $\sigma =$
(a) $\frac{NPSH}{\sqrt{H}}$ (b) $\frac{H}{NPSH}$
(c) $\frac{H}{\sqrt{NPSH}}$ (d) $\frac{NPSH}{H}$

Q.8 The minimum head across the impeller for the delivery to commence is
(a) $h+\left(h_{f_s}+h_{f_d}\right)-\frac{V_s^2}{2g}-\frac{V_d^2}{2g}$
(b) $h+\left(h_{f_d}+h_{f_s}\right)+\frac{V_s^2}{2g}+\frac{V_d^2}{2g}$
(c) $h+\left(h_{f_s}+h_{f_d}\right)+\frac{V_s^2}{2g}-\frac{V_d^2}{2g}$
(d) $h-\left(h_{f_s}+h_{f_d}\right)-\frac{V_s^2}{2g}-\frac{V_d^2}{2g}$

Q.9 The impeller tips of a centrifugal pump have radii of 10 cm and 30 cm. Determine the minimum speed at which delivery will commence against a static head of 15 m.
(a) 330 rpm (b) 460 rpm
(c) 580 rpm (d) 646 rpm

Q.10 Discharge of a double acting reciprocating pump is
(a) LAN (b) 2LAN
(c) $\frac{LAN}{60}$ (d) $\frac{2LAN}{60}$
where, L = length of stroke
A = cross-section area of piston
N = speed of crank in RPM

Q.11 Due to rotation of impeller of a centrifugal pump in liquid surroundings,
(a) a momentum acts on the liquid
(b) a torque acts on the liquid in the same direction of rotation
(c) a torque acts on the liquid in a direction opposite to the direction of rotating of impeller
(d) just loss of energy alone takes place

Q.12 Detection of cavitation in hydro machinery can be made
(a) by visual or photographic observations of vapour pockets or bubbles on the runner vanes
(b) by observation and measurement of noise and vibrations accompanying the operation of the machine
(c) by change of hydraulic performance of the machine
(d) by all of the above methods

Q.13 Hydraulic losses in a pump may be due to
1. shock or eddy losses at the entrance to and the exit from the impeller
2. friction losses in the impeller
3. friction and eddy losses in the guide vanes and casing
Which of these statements are correct?
(a) Both 1 and 2 (b) Both 1 and 3
(c) Both 2 and 3 (d) 1, 2 and 3

Q.14 In a pump, the suction and delivery pipes are of the same size and are at the same level. At a given discharge, the loss of head between a point A on the suction side and a point B on the delivery side is 3.0 m. If the pressure at point B is 120 kPa and the head developed by the pump is 10 m, the pressure at point A is
(a) 51.5 kPa (b) –7.25 kPa
(c) –188.6 kPa (d) 29.37 kPa

Q.15 A centrifugal pump discharges 260 litres of water per second when running at 600 rpm. The impeller diameter at the out let is 80 cm. It develops a head of 15.3 m. What is the approximate minimum starting speed?
(a) 425 rpm (b) 450 rpm
(c) 475 rpm (d) 500 rpm

Q.16 If the radius of centrifugal pump impeller is reduced from 10 cm to 9 cm, the head developed by the pump will change from 10 m to
(a) 9 m of water
(b) 8.1 m of water
(c) 9.487 m of water
(d) 11.11 m of water

Q.17 Consider the following statements:
1. A reciprocating pump does not need priming.
2. A centrifugal pump can run at high speed.
3. A centrifugal pump has high maintenance cost as compared to reciprocating pump.
Which of these statement/s is/are correct?
(a) only 1 (b) both 1 and 2
(c) both 1 and 3 (d) All of these

Q.18 Pumps may be put in the increasing order of specific speeds as:
(a) centrifugal pumps, mixed flow pumps, axial flow pumps
(b) centrifugal pumps, axial flow pumps, mixed flow pumps
(c) mixed flow pumps, axial flow pumps, centrifugal pumps
(d) mixed flow pumps, centrifugal pumps, axial flow pumps

Q.19 Which one of the following statement regarding reciprocating pump is correct?

(a) Friction head is mainly responsible for causing cavitation in a reciprocating pump at the beginning of the suction stroke.

(b) Effect of acceleration pressure on reciprocating pumps appears parabolic and has the maximum effect at the middle of the delivery stroke.

(c) Air vessel reduces the acceleration head and consequently reduces the effect of friction head also.

(d) The maximum permissible suction lift in a double acting reciprocating pump is independent of vapour pressure.

Q.20 Consider the following statements related to centrifugal pumps.

1. Centrifugal pumps with blades facing backward have fast runners.
2. Multistage pumps have two or more impellers installed in series so that the discharge is increased.
3. Diffusion type centrifugal pumps are called turbine pumps
4. A centrifugal pump with rising characteristics is used when actual lift is small and the amount of flow is constant.

Which of these statements are correct?

(a) 1, 2 and 3
(b) 1, 2 and 4
(c) 1, 3 and 4
(d) 2, 3 and 4

Q.21 Consider the following statements relating to centrifugal pumps.

1. In centrifugal pumps discharge is proportional to speed of the impeller.
2. In centrifugal pumps discharge is proportional to the cube of the impeller diameter.
3. Specific speed is a criterion for selection of centrifugal pumps.
4. Cavitation in centrifugal pumps can be eliminated by avoiding sharp bends, lowering velocity in suction pipe and by lowering temperature.

Which of these statements are correct?

(a) 1, 2 and 3
(b) 1, 2 and 4
(c) 2, 3 and 4
(d) 1, 3 and 4

Q.22 Consider the following statements:

1. The specific speed for turbine is inversely proportional to $H^{5/4}$
2. The specific speed for turbine is inversely proportional to $H^{3/4}$
3. The specific speed for pumps is inversely proportional to $H^{5/4}$
4. The specific speed for pumps is inversely proportional to $H^{3/4}$

Which of these statements are correct?

(a) 1 and 4
(b) 2 and 4
(c) 1 and 3
(d) 2 and 3

Q.23 Assertion (A): Inlet side of a pump is less susceptible to cavitation damage.
Reason (R): Cavitation occurs when the velocity is high and pressure is low.

(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.24 Determine the number of impellers required for a multistage pump to lift 3840 litres per minute of water against a total head of 80 m at a speed of 720 rpm. Given that the limiting N_s for each impeller is 720 units.

(a) 6 (b) 5
(c) 4 (d) 3

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Answers Hydraulic Pumps

1. (c)	2. (b)	3. (b)	4. (b)	5. (b)	6. (c)	7. (d)	8. (c)	9. (c)	10. (d)
11. (c)	12. (d)	13. (d)	14. (a)	15. (c)	16. (b)	17. (b)	18. (a)	19. (c)	20. (c)
21. (a)	22. (a)	23. (d)	24. (b)						

Explanations Hydraulic Pumps

1. (c)
The specific speed,

$$N_s = \frac{N\sqrt{Q}}{H^{3/4}} = \frac{1414 \times \sqrt{256}}{(16)^{0.75}} = 2828$$

Type of pump	Specific speed
Slow speed radial flow	300-900
Medium speed radial flow	900-1500
High speed radial flow	1500-2400
Mixed flow or screw type	2400-5000
Axial flow or propeller type	3400-15,000

2. (b)
Equating head coefficients, we get

$$\frac{N_1 D_1}{\sqrt{H_1}} = \frac{N_2 D_2}{\sqrt{H_2}}$$

$$\therefore \quad D_2 = \left(\frac{1000}{1000}\right) \times \sqrt{\frac{16}{25}} \times 300 = 240 \text{ mm}$$

3. (b)

$$\text{Slip} = (Q_{th} - Q_a)$$

$Q_{th} < Q_a$ or $C_d > 1$

If coefficient of discharge is more than one, negative slip would occur.

6. (c)
Air vessel ensures continuous supply of water at a uniform rate in a reciprocating pump. It results in saving of work against friction.
Percentage of work saved during stroke in
(i) single acting pump is 84.8%
(ii) double acting pump is 39.2%
The air vessels change the indicator diagram of the reciprocating pump.

9. (c)

$$h = \frac{\omega^2(r_2^2 - r_1^2)}{2g}$$

$$15 = \frac{\omega^2}{2g}((0.30)^2 - (0.10)^2)$$

$$\omega = \sqrt{\frac{2 \times 15 \times 9.81}{((0.3)^2 - (0.1)^2)}}$$

$$= 60.65 \text{ rad/s}$$

$$N = \frac{60\omega}{2\pi} = \frac{60 \times 60.65}{2 \times 3.14}$$

$$= 579.19 \simeq 580 \text{ rpm}$$

10. (d)
For single acting reciprocating pump,

$$\text{Discharge, } Q = \frac{LAN}{60}$$

For double acting reciprocating pump, discharge gets doubled

$$\text{Hence,} \quad Q = \frac{2LAN}{60}$$

23. (d)
Inlet side of a pump is more susceptible to cavitation damage.

24. (b)
If H_m is the manometric head developed by each pump, then

$$N_s = \frac{N\sqrt{Q}}{H_m^{3/4}}$$

Given, $N_s = 720$ rpm,
$N = 720$ rpm
$Q = 3840$ litres per minute
$= 64$ lps $= 0.064$ m^3/s

$$\therefore \quad 720 = \frac{720 \times \sqrt{64}}{H_m^{3/4}}$$

$$\therefore \quad (H_m)^{3/4} = 8$$

$$\therefore \quad H_m = (8)^{4/3} = 16 \text{ m}$$

$$\therefore \text{ No. of impellers required} = \frac{80}{16} = 5$$

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