Chapter -6

PUMPS & PUMPING SYSTEM

Poll Questions
Time: 5 minutes

1. The intersection point of the centrifugal pump characteristic curve and the design system curve is the

a) Pump efficiency point

b) Best efficiency point

c) System efficiency point

d) None of the above

2. If the speed of the pump is doubled, power goes up by ----------

a) 2 times

b) 6 times

c) 8 times

d) 4 times

3. Shaft power of the motor driving a pump is 30 kW. The motor efficiency is 0.92 and Pump efficiency is 0.5. The power drawn by the motor will be

a) 65.2 kW

b) 15 kW

c) 30 kW

d) 32.6 kW

4. If the power drawn by the motor driving a pump is 20 kW at a 91% efficiency, and the hydraulic power of a motor pump set is 12.5 kW, the pump efficiency will be__

a) 68.7%

b) 62.5%

c) 56.8%

d) None of the above

5. The most efficient method of flow control in a pumping system is _____.

a) Throttling the flow

b) Speed control

c) Impeller trimming

d) Bypass control

6. In case of Centrifugal pumps, Impeller diameter changes are generally limited to reducing the diameter to about ----------of maximum size

a) 75%

b) 50%

c) 25%

d) None of the above

7. The head generated by a centrifugal pump is

a) Independent of the density of the liquid being pumped

b) Directly proportional to the density of the liquid being pumped

c) Inversely proportional to the density of the liquid being pumped

d) Proportional to the square of the density of the liquid being pumped

8. Small bypass lines are installed sometimes to

a) Control Flow rate

b) Control pump delivery head

c) Prevent pump running at zero flow

d) Reduce pump power consumption

9. Increasing the suction pipe diameter in a pumping system will ----------

a) Reduce NPSHA

b) Increase NPSHA

c) Decrease NPSHR

d) Increase NPSHR

10. A water pump is delivering 20 m3/hr at ambient conditions. The impeller diameter is trimmed by 10%. This will reduce the pump discharge by

a) 18m3/hr

b) 2m3/hr

c) 0.2m3/hr

d) None of the above

Green Tech LEARNING

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Answers

1. b
2. c
3. d Power drawn by the motor = Pump Shaft power/Motor efficiency = 30/0.92 = 32.6KW
4. a. Pump shaft Power = Motor Input Power × Motor Efficiency = 20×.91 = 18.2KW

   Pump Efficiency = Hydraulic Power / Pump shaft Power = (12.5 /18.2)×100 = 68.7%
5. b.
6. a.
7. a
8. c
9. b
10. b. Q α D Dia trimmed by 10%, discharge reduced by 10% = 2m3/hr

Short Questions

- Explain Parallel & Series operation of pumps with necessary pump curves
- Briefly explain with sketch the concept pump Head flow characteristics and system resistance
- What is Cavitation, what are the undesirable effects of cavitation in a Pumping system?
- A pump is delivering 50m3/hr of water with a discharge pressure of 3.5kg/cm2. The water is drawn from a sump where water level is 5m below the pump centerline. The power drawn by the motor is 9.5kW at 90% motor efficiency. Find out the pump efficiency?
- The Suction head of a pump is 3m below the pump centerline. The discharge pressure is 2.8kg/cm2. The flow rate of water is 120m3/hr. Find out the pump efficiency, if the actual power input to the motor is 15kW with an operating efficiency of 0.9

Solution

- Hydraulic Power = {Q (m3/s) × H (m)×ρ (kg/m3)×g (m/s2)}/1000

Discharge head = 3.5kg/cm2 = 35m

Total Head = 35-(-5) =40m

Hydraulic power = (50×40×1000×9.81)/3600×1000 = 5.45kW

Pump Efficiency = Hydraulic Power / Pump shaft Power

Pump shaft Power = Motor Input × Motor Efficiency

= 9.5 × 0.9 = 8.55 kW

Pump Efficiency = (5.45/8.55)×100 = 63.74%

Solution

- Hydraulic Power = {Q (m3/s) × H (m)×ρ (kg/m3)×g (m/s2)}/1000

Discharge head = 2.8kg/cm2 = 28m

Total Head = 28-(-3) =31m

Hydraulic power = (120×31×1000×9.81)/3600×1000 = 10.137kW

Pump Efficiency = Hydraulic Power / Pump shaft Power

Pump shaft Power = Motor Input × Motor Efficiency

= 15 × 0.9 = 13.5 kW

Pump Efficiency = (10.137/13.5)×100 = 75%

Problem-1

A pump is filling water in to a rectangular overhead tank of 5 m x 4 m with a height of 8 m. The inlet pipe to the tank is located at height of 20 m above ground. The following additional data is collected

Pump suction : 3 m below pump level

Overhead tank overflow line : 7.5 m from the bottom of the tank

Power drawn by motor : 5.5 kW

Motor efficiency η : 92%

Time taken by the pump to fill the overhead tank up to overflow level : 180 minutes

Assess the pump efficiency

Solution

Volume of the tank = 5 x 4 x 7.5 = 150 m3

Flow = 150/3 = 50 m3 /hr

Hydraulic power = Q (m3 /s) x total head (m) x 1000 x 9.81 /1000 =

= (50/3600) x (20 –(-3)) x 1000 x 9.81/1000 = 3.13 kW

Power input to pump = 5.5 x 0.92 = 5.06 kW Pump efficiency = 3.13/5.06 = 61.9%

Problem-2

The total System resistance of a Water piping System is 30 m and the Static head is 10m at the designed water flow. Calculate the system resistance offered at 75%, 50% and 25% of water flow.

Solution

Total System resistance = 30m = Static head + Dynamic head

Static Head = 10m independent of flow- Constant

Dynamic head at designed water flow = 30-10 = 20m

Dynamic head at 75% water flow = $(.75)^2 \times 20 = 11.25$m

Dynamic head at 50% water flow = $(.5)^2 \times 20 = 5.0$m

Dynamic head at 25% water flow = $(.25)^2 \times 20 = 1.25$m

Total System resistance at 75% water flow= 10+11.25 = 21.25m

Total System resistance at 50% water flow= 10+ 5 = 15m

Total System resistance at 25% water flow=10+1.25 = 11.25m

Problem-3

A Centrifugal pump pumping water operates at 35m3/hr and at 1440 rpm. The pump operating efficiency is 68% and motor efficiency is 90%. The discharge pressure gauge shows 4.4 kg/cm2. The suction is 2m below the pump center line. If the speed of the pump is reduced by 50% estimate the new flow, and Power.

Solution

- Hydraulic Power = {Q (m3/s) × H (m)×ρ (kg/m3)×g (m/s2)}/1000

Discharge head = 4.4kg/cm2 = 44m

Total Head = 44-(-2) =46m

Hydraulic power = (35×46×1000×9.81)/3600×1000 = 4.387kW

Speed is reduced by 50%

Affinity law $Q \alpha N$

$H \alpha N^2$

$P \alpha N^3$

Flow is also reduced to 50% = 35/2 =17.5 m3/hr

Hydraulic power = 4.387/8 = 0.548kW