PUMPS AND PUMPING SYSTEMS

QUESTION

In a large paper plant, the following are the design and measured operating parameters for a clear water pump.

Parameter	Design	Operating
Flow Q (m³/h)	800	550
Head H (m WC)	55	24 (after delivery valve)
Power P (kW)	160	124
RPM	1485	1485

The required water flow rate varies from 500 m³/h to 700 m³/h. For this reason, the pump flow rate has been reduced by partially closing the delivery valve. Motor efficiency is 93%.

Calculate the following:

1. Calculate the operating efficiency
2. Explain what would be the best option to obtain the required flow rate variation
3. Calculate the power savings if the options suggested under question 2 would reduce the flow rate of the pump is 550 m³/h

SOLUTION

1. Calculate the operating efficiency

Efficiency of the pump

$$= \frac{Q \times H \times g}{3600 \times P \times \text{motor efficiency}}$$

$= (550 \times 24 \times 9.81) / (3600 \times 124 \times 0.93)$

$= 0.3867 = 38.67\%$

2. Explain what would be the best solution to obtain the required flow rate variation

The pump is operating at a poor efficiency of 38.67% due to throttling of the flow. Since the pump discharge requirement varies from 500 m³/h to 700 m³/h, the ideal option would be to operate with a variable speed drive (VSD).

3. Calculate the power savings if the options suggested under question 2 would reduce the flow rate of the pump is 550 m³/h

According to affinity laws:

- Relationship flow rate Q and RPM: $Q_1/Q_2 = N_1/N_2$
- Relationship head H and RPM: $H_1/H_2 = (N_1/N_2)^2$
- Relationship power P and RPM: $P_1/P_2 = (N_1/N_2)^3$

For a flow rate Q1 = 550 m³/h, the reduced speed of pump (N1 in RPM) would be:

$$= \frac{550}{800} = \frac{N_1}{1485}$$

$N_1 = 1021$ RPM

The new power P_1:

$= P_1 / 160 = (1021 / 1485)^3$

$P_1 = 52$ kW

Power savings

= previous operating power – new operating power

= 124 kW - 52 kW

= 108 kW