To evaluate the operating cost of a pumping system for board examinations, we must systematically trace the flow of energy from its electrical source to its final hydraulic delivery. The problem requires filling a 25m^3 tank within an operational timeframe of exactly one hour (1hr). This gives a volumetric flow rate or pump capacity (Q) of:

$$Q = \left(\frac{25\, m^3}{1\, hr}\right)\left(\frac{1\, hr}{60\, s}\right) = 0.006944 \frac{m^3}{s}$$

The system operates against a Total Dynamic Head (TDH) of 25 m. Using the specific weight of water at standard conditions $\left(\gamma_w = 9.81\, kN/m^3\right)$, we compute the **Water Power (WP)**, which is the net useful hydraulic energy rate delivered directly to the liquid medium:

$$WP = Q\gamma_w TDH$$

Accounting for Mechanical and Electrical Inefficiencies

Energy conversions in real systems involve losses. The mechanical power required at the pump shaft, known as the **Brake Power (BP)**, is higher than the net water power due to the pump's internal hydraulic, volumetric, and mechanical friction losses (η_P = 85%):

$$BP = \frac{WP}{\eta_P} = \frac{1.703125\, kW}{0.85} = 2.0037\, kW$$

Similarly, the electric motor driving the shaft has its own electrical and magnetic winding losses (η_M = 80%). The **Electrical Power (EP)** drawn from the utility grid represents the total energy input rate to the system:

$$EP = \frac{BP}{\eta_M} = \frac{2.0037\, kW}{0.80} = 2.5046\, kW$$

Operating Cost Determination

To find the final economic expenditure, we calculate the total electrical energy consumed over the one-hour duration (t=1 hr) and multiply it by the local utility rate of ₱0.38/kW-hr:

Energy Consumed = (EP)(t) = $(2.5046\, kW)(1\, hr) = 2.5046\, kW - h$

Total Cost = $(2.5046\, kW - hr)\left(\frac{₱0.38}{kW-hr}\right)$

Total Cost = ₱0.952

This problem highlights the significant impact of compounding mechanical and electrical losses. Although the pump has an efficiency of 85% and the electric motor operates at 80%, the overall combined efficiency of the system drops to just 68% ($\eta_{Overall}$ = 0.85 x 0.80 = 0.68). In industrial applications, this means that more than 32% of the electrical energy purchased from the utility is lost as heat inside the motor windings and pump casing rather than being used to move the fluid. Engineers must design systems to keep components running near their Best Efficiency Points (BEP) to prevent these losses from driving up operational costs over time.