WelTec
Te Whare Wānanga o te Awakairangi

DC fundamentals EE3103

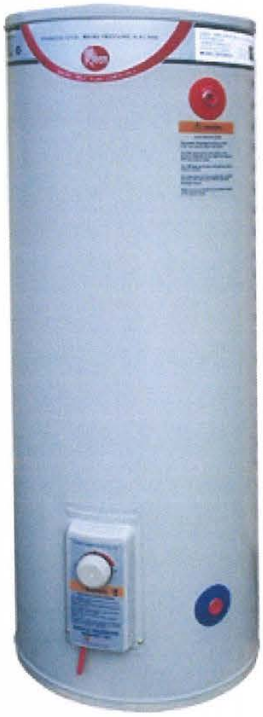
Student workbook 2019

Power and energy theory and calculation exercises

Student name

Question 1

Calculate the time taken to heat the water in a hot water cylinder that is 2m tall and has a diameter of 750mm.
The cylinder has a 10kW element fitted and insulated to 85%.
Initial water temperature is 15^0C and required temperature is 65^0C



Question 2

A tank of water measures 1.5m wide, 2m high and 0.5m deep.
The water in the tank needs to be heated from 25^0C to 90^0C in 21 hours.
Efficiency is poor at 55%.
Calculate the most appropriate size element to carry out this task and the cost to heat this water if the tariff unit is 25 cents.
Calculate the current the element draws from the 230 volt supply.
Finally calculate the savings in cost over a year if a thermal blanket covers the tank that raises the efficiency to 90% and a whole tank of water is used 335 days of the year.

Question 1 answers

Calculate the time taken to heat the water in a hot water cylinder that is 2m tall and has a diameter of 750mm.
The cylinder has a 10kW element fitted and insulated to 85%.
Initial water temperature is 15^0C and required temperature is 65^0C

$2m \times (0.75 \div 2)^2 \times \pi = 0.883\ m^3 = 883kg$

$883kg \times (65 - 15) \times 4190 = 185MJ$

$\frac{185MJ}{3.6} = 51.38\ kWh$

$\frac{51.38\ kWh}{0.85} = 60.45\ kWh$

$\frac{60.45\ kWh}{10kW} = 6\ hours$

Question 2 answer

A tank of water measures 1.5m wide, 2m high and 0.5m deep.
The water in the tank needs to be heated from 25^0C to 90^0C in 21 hours.
Efficiency is poor at 55%.
Calculate the most appropriate size element to carry out this task and the cost to heat this water if the tariff unit is 25 cents.
Calculate the current the element draws from the 230 volt supply.
Finally calculate the savings in cost over a year if a thermal blanket covers the tank that raises the efficiency to 90% and a whole tank of water is used 335 days of the year.

$1.5m \times 2m \times 0.5m = 1.5m^3$ $\quad Q = 1500 \times 65 \times 4190 = 408.5MJ$

$408.5 \div 0.55 = 742.8\ MJ$ $\quad 742.8\ MJ \div 3.6 = 206.3\ kWh$

$\frac{206.3\ kWh}{21h} = 9.82$ (10kW) element size

$206.3\ kWh \times \$\ 0.25 = \$51.58$ cost to heat the tank of water

$\frac{10{,}000W}{230\ volts} = 43.5\ amps$ element current draw

$\$51.58 \times 335 = \$17{,}279$ cost at 55%

$408 \div 0.90 = 453.3\ MJ$ $\quad 453.3\ MJ \div 3.6 = 125.93kWh$

$125.93 \times \$0.25 \times 335 = \$10{,}546$ $\quad \$17{,}279 - \$10{,}546 = \$6732.70$ savings