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Fluid Mechanics: Fu ıdamentals and Applications (4th Edition)

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Problem

Water at 15°C from a garden hose fills a 1.5 L container in 2.85 s. Using unity conversion ratios and showing all your work, calculate the volume flow rate in liters per minute (Lpm) and the mass flow rate in kg/s.

Step-by-step solution

Step 1 of 4

Calculate volume flow rate in Lps.

$$Q = \frac{V}{t}$$

Here, the volume flowing is *V* and time taken for flow is *t*.

Substitute 1.5 L for *V* and 2.85 s for *t*.

$$\begin{aligned} Q &= \frac{1.5\ \text{L}}{2.85\ \text{s}} \\ &= 0.52\ \text{Lps} \end{aligned}$$

Comment

Step 2 of 4

Calculate the volume flow rate in Lpm.

$$\begin{aligned} Q &= 0.52\ \frac{\text{L}}{\text{s}} \times \frac{60\ \text{s}}{\text{min}} \\ &= 31.2 \frac{\text{L}}{\text{min}} \\ &= 31.2\ \text{Lpm} \end{aligned}$$

Therefore, the volume flow rate in Lpm is $\boxed{31.2\ \text{Lpm}}$.

Comment

Step 3 of 4

Obtain the relation for the mass flow rate in kg/s.

$\dot{m} = \rho \times Q$ ...... (1)

Here, density of water is ρ and the volume flow rate is *Q*.

Convert the volume in m^3.

$$=1.5\times10^{-3}\ \text{m}^3$$

Calculate the volume flow rate i... (m^3/s).

$$Q=\frac{V}{t}$$

Substitute $1.5\times10^{-3}\ \text{m}^3$ for V and 2.85 s for t.

$$Q=\frac{1.5\times10^{-3}\ \text{m}^3}{2.85\ \text{s}}$$
$$=0.5263\times10^{-3}\ \text{m}^3/\text{s}$$

Obtain the density of water from table A-3, "Properties of saturated water" at $15°\text{C}$ as follows:

$$\rho=999.1\ \text{kg/m}^3$$

Comment

Step 4 of 4

Calculate the mass flow rate in kg/s.

Substitute $0.5263\times10^{-3}\ \text{m}^3/\text{s}$ for Q and $999.1\ \text{kg/m}^3$ for ρ in equation (1).

$$\dot{m}=\rho\times Q$$
$$=999.1\frac{\text{kg}}{\text{m}^3}\times0.5263\times10^{-3}\frac{\text{m}^3}{\text{s}}$$
$$=0.5258\ \text{kg/s}$$

Therefore, the mass flow rate in kg/s is .

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