

M505: CONTROL OF HAZARDOUS SUBSTANCES

CALCULATION EXERCISES - ANSWERS

QUESTION 1

Using the formulae $\rho_v = 0.6 v^2$ for standard temperature and pressure

$$\begin{aligned}\rho_v &= 0.6 \times 30^2 \\ &= 0.6 \times 900 \\ &= 540 \text{ Pascals}\end{aligned}$$

QUESTION 2

Using the formulae $Q = vA$

$$\begin{aligned}1 &= v \times 0.04 \\ v &= 25 \text{ ms}^{-1}\end{aligned}$$

Substituting in the formula $\rho_v = 0.6 v^2$

$$\begin{aligned}\rho_v &= 0.6 \times 25^2 \\ &= 375 \text{ Pascals}\end{aligned}$$

Substituting in the formula

$$\begin{aligned}\rho_T &= \rho_s + \rho_v \\ &= -300 + 375 \\ &= 75 \text{ Pascals}\end{aligned}$$

QUESTION 3

$$\text{Concentration} = \frac{\text{Mass}}{\text{Volume}} \quad \begin{matrix} (\text{mg}) \\ (\text{m}^3) \end{matrix}$$

$$= \frac{100 \times 1000}{10 \times 3 \times 10}$$

$$= 333 \text{ mg m}^{-3}$$

QUESTION 4

Calculate the average face velocity = 0.18 ms^{-1}

Using the formulae $Q = vA$ calculate the average airflow through the fume cupboard

$$\begin{aligned} Q &= 0.18 \times (1.2 \times 0.6) \\ &= 0.13 \text{ m}^3\text{s}^{-1} \end{aligned}$$

Substituting in the formulae $Q = vA$ for the duct

$$\begin{aligned} 0.13 &= v \times (\pi r^2) \\ 0.13 &= v \times (3.142 \times 0.1^2) \\ 0.13 &= 0.03142 v \\ v &= \frac{0.13}{0.03142} \\ &= 4.1 \text{ ms}^{-1} \end{aligned}$$

QUESTION 5

Air is entering the duct from all directions towards the source of negative pressure. Viewed in three dimensions, this equates to a sphere, the formulae for its surface area being $A = 4\pi r^2$

$$\begin{aligned} \text{Using the formulae } Q &= vA \\ 0.22 &= v \times 4 \times 3.142 \times (0.12)^2 \\ 0.22 &= v \times 0.18 \\ \therefore v &= \frac{0.22}{0.18} \\ &= 1.22 \text{ ms}^{-1} \end{aligned}$$

QUESTION 6

PITOT TRAVERSE WORKSHEET						
Date:	Time:		P_s:	-630 Pa		
Temp:			Description:	Round/Galvanised		
Equipment:	Main Duct		Location:	Furnace No. 3		
	Vertical			Horizontal		
	P_T	P_V	V (ms⁻¹)	P_T	P_V	V (ms⁻¹)
1	180	810	36.8	155	785	36.2
2	260	890	38.5	230	860	37.9
3	270	900	38.7	265	895	38.6
4	285	915	39.1	280	910	38.9
5	300	930	39.4	295	925	39.3
6	300	930	39.4	315	945	39.7
7	270	900	38.7	285	915	39.1
8	280	910	38.9	255	885	38.4
9	240	870	38.1	245	875	38.2
10	165	795	36.4	185	815	36.9
Average Velocity Pressure = 883 Pa Average Velocity = 38.4 ms ⁻¹ Volume Flow Rate = 10.9 m ³ s ⁻¹						

Airflows at the surface of the duct are slower due to frictional forces.

QUESTION 7

Using the formulae $C = C_0 e^{-Rt}$

Where $R = \frac{Q}{V}$

$$\begin{aligned}
 C &= 1500 \times e^{\left(\frac{-0.944}{623}\right)} \times 900 \\
 &= 1500 \times e^{-1.364} \\
 &= 385 \text{ ppm}
 \end{aligned}$$