Answer on Question 71825, Physics, Other

Question:

The inlet section of a wind tunnel has a diameter of $500\ mm$ and the intake air velocity is $25\ m/s$. If the working section requires an air velocity of $50\ m/s$ calculate the cross-sectional area and diameter of the working section.

Solution:

We can find the cross-sectional area and diameter of the working section from the Law of Continuity:

$$A_i v_i = A_w v_{w,}$$

here, $A_i = \frac{\pi d_i^2}{4}$, $A_w = \frac{\pi d_w^2}{4}$ are the cross-sectional areas of the inlet and working section of a wind tunnel, respectively; d_i, d_w are diameters of the inlet and working sections of a wind tunnel, respectively; v_i is the intake air velocity in the inlet section of the wind tunnel; v_w is the air velocity in the working section of the wind tunnel.

Let's first calculate the cross-sectional area of the working section:

$$A_w = \frac{A_i v_i}{v_w} = \frac{\frac{\pi d_i^2}{4} \cdot v_i}{v_w} = \frac{\frac{\pi \cdot (0.5\ m)^2}{4} \cdot 25\ \frac{m}{s}}{50\ \frac{m}{s}} = 0.098\ m^2.$$

Finally, we can calculate the diameter of the working section:

$$A_w = \frac{\pi d_w^2}{4},$$

$$d_w = \sqrt{\frac{4A_w}{\pi}} = \sqrt{\frac{4 \cdot 0.098\ m^2}{\pi}} = 0.35\ m.$$

Answer:

$A_w = 0.098\ m^2$, $d_w = 0.35\ m$.