

The drag characteristics of a blimp 5 m in diameter and 60 m long are to be studied in a wind tunnel. If the speed of the blimp through still air is 10 m/s, and if a 1/10 scale model is to be tested, what airspeed in the wind tunnel is needed for dynamic similarity? Assume the same air temperature and pressure for both the prototype and model.

SOLUTION:

For dynamic similarity, equate the model and prototype Reynolds numbers.

$$\begin{aligned} \text{Re}_P &= \text{Re}_M \\ \Rightarrow \left(\frac{VD}{\nu} \right)_P &= \left(\frac{VD}{\nu} \right)_M \end{aligned}$$

Since both the model and prototype use air at the same temperature and pressure as the working fluid, $\nu_P = \nu_M$.

$$\Rightarrow V_M = V_P \left(\frac{D_P}{D_M} \right) = (10 \text{ m/s}) \left(\frac{10}{1} \right)$$

$$\boxed{\therefore V_M = 100 \text{ m/s}}$$

Note that the model speed is still low enough that Mach number effects (i.e., compressibility effects) do not come into play.