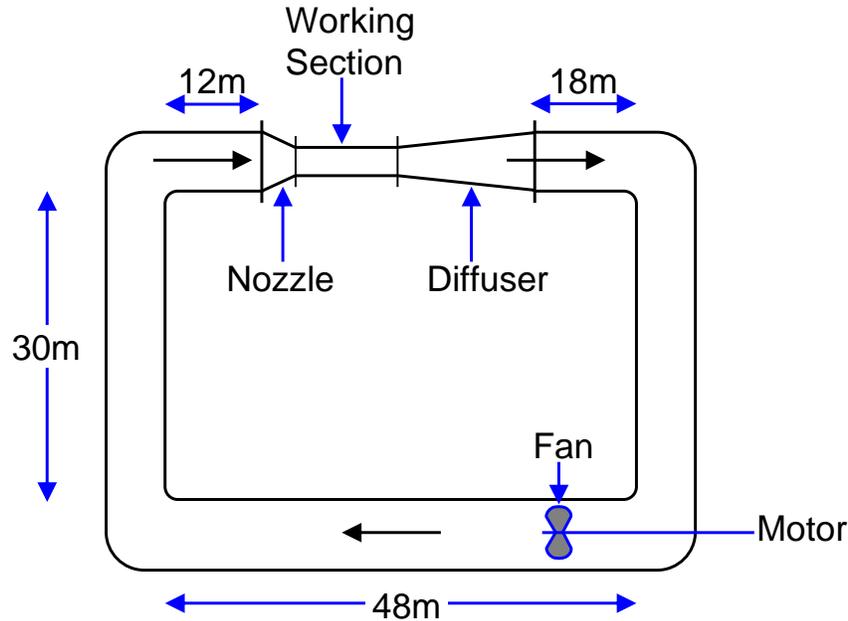


Problem 205D

A wind tunnel is constructed primarily of 6m. diameter piping arranged with four 90° elbows as shown in the sketch below.



The working section is 3 m in diameter and is preceded by a nozzle and followed by a diffuser. A fan is installed to create the flow and is 80% efficient. If the tunnel is to achieve an air velocity of 80 m/s in the working section, find the power which must be provided to the fan (in HP where $1 \text{ HP} = 746 \text{ kg m}^2/\text{s}^3$). Assume the following losses occur in the tunnel:

1. A loss in each of the four corner bends equivalent to a length of 20 diameters of the large piping.
2. A friction factor, f , of 0.02 in the 138 m of 6 m diameter pipe.
3. A total loss in the nozzle, working section and diffuser equivalent to one fifth of the velocity head (the $\frac{1}{2}\rho u^2$) in the working section.

Air at these speeds can be assumed essentially incompressible with a density of 1.2 kg/m^3 .