**Solution 1.25**

The flow of air through a wind turbine is considered. Based on unit considerations, a proportionality relation is to be obtained for the mass flow rate of air through the blades.

***Assumptions*** Wind approaches the turbine blades with a uniform velocity.

***Analysis*** The mass flow rate depends on the air density, average wind velocity, and the cross-sectional area which depends on hose diameter. Also, the unit of mass flow rate  is kg/s. Therefore, the independent quantities should be arranged such that we end up with the proper unit. Putting the given information into perspective, we have

 [kg/s] is a function of *ρ* [kg/m3], *D* [m], and *V* [m/s}

It is obvious that the only way to end up with the unit “kg/s” for mass flow rate is to multiply the quantities *ρ* and *V* with the square of *D*. Therefore, the desired proportionality relation is



or,



where the constant of proportionality is *C* =*π*/4 so that 

***Discussion*** Note that the dimensionless constants of proportionality cannot be determined with this approach.