TECH TIPS

Conductance of a Tube

This page provides a simplified method for calculating the conductance of a tube and the resulting limitations that the tube places on pumping speed.

Calculation of Conductance

The following formulas are for dry air at 20º C in the molecular flow region of vacuum.

Conductance of a long tube:

$$C = 75D^3/L$$

C is Conductance in liters-per-second
D is the tube inner diameter in inches
L is the tube length in inches
So, for example, D is 2.0 inches and L is 20.0 inches.
C = (75 x 8)/20 = 30 liters-per-second

Conductance Limitations on Pumping Speed

The influence of tube conductance on pumping speed is calculated as follows:

$$1/S\,act = 1/S\,spec + 1/C\,tube$$

Where:

Sspec is the specified pumping speed of the pump
Ctube is the conductance of the tube attached to the pump
Sact is the actual pumping speed at the end of the tube away from the pump
So, for example, if Sspec is 50 liters-per-second and Ctube is 30 liters-per-second,
1/Sact = 1/50 +1/30 = 0.020 + 0.033 = 0.053, and,
Sact = 1/.0053 = 18.87 liters per second

In other words, the conductance of the tube has resulted in an effective loss of pumping speed of more than 60 percent!

For more detailed discussions of conductance of apertures, short tubes or different shapes, see reference materials such as:

1. *Handbook of Vacuum Science and Technology*, Hoffman, Singh and Thomas, Academic Press, 1998
2. *Scientific Foundation of Vacuum Technique*, Dushman and Lafferty, Wiley, 1962.