Vent Hole Calculations

In order for a barometric pressure sensing altimeter to determine altitude it must be able to measure the outside atmospheric pressure. This means that an altimeter mounted inside a rocket needs to have "vent holes" to let the internal air equalize with the outside air pressure. The technical term for these vent holes is "static pressure ports". They should be on the side of the rocket so that no air is directly forced into them during flight. They should also be well away from the nosecone joint or any other transitions in the body diameter since these can cause turbulence and either increased or decreased pressure regions.

There are two charts presented below that can be used to determine the proper size of static pressure port holes. The equations that were used to generate these charts are also shown near the end of this page.

Static Pressure Port Hole Size

To use the charts below, first decide how many holes you want to drill around the circumference of the altimeter bay. The first chart is for three holes and the second chart is for four holes. Now find the row in the chart that corresponds to the inside diameter of the altimeter bay compartment. As you look across this row, find the first column which has a length longer than the length of your altimeter bay compartment. The top of that column indicates the proper hole size to use. An example follows these charts.

Example

Assume we have a rocket with an altimeter bay that is 3.9 inches across the inside diameter and is 8 inches long. Also assume that we want to use just three pressure port holes. To find the correct size for these holes, we use the upper chart since it applies to the case for three holes. In the left most column of that upper chart we find the 3.9 inch diameter listed in the fourth row from the bottom.   We now scan across that row looking for the first column that has a length greater than the 8 inches length of our compartment. The column with 9.81 in it meets that criteria. The top of that column is labeled with a 5/32" drill size. That means we need to drill three holes equally spaced around the rocket that are each 5/32" in diameter.

Note that if we had elected to use four holes instead, then we would use the lower chart. That chart indicates we could get by with 1/8" diameter holes when we use four of them.

These charts were created based on the equations presented below. The charts assume we need the equivalent of a 1/4" diameter hole per 100 cubic inches of volume.

Calculating Static Pressure Port Size

A good rule of thumb for the static pressure port is to use a 1/4" diameter hole for every 100 cubic inches in the altimeter bay compartment that is being vented. This can be described by the following equation:

$$A_1 = V*(A_{ref}/V_{ref})$$

where A_1 is the area in square inches of a single static pressure port hole and **V** is the volume in cubic inches of the compartment. A_{ref} is the area of our reference 1/4" diameter hole and V_{ref} is our reference volume of 100 cubic inches.   For example, using this equation, if **V =** 100 cubic inches then it cancels with V_{ref} and leaves $A = A_{ref}$, which means we need a hole with the same cross sectional area as a 1/4" diameter hole. If **V =** 200 cubic inches, then A_1 will turn out to be twice the area of a 1/4" diameter hole. Therefore, the equation yields one 1/4" diameter hole per 100 cubic inches of volume.

The volume of the compartment can be calculated from the following equation:

$$V = (pi/4)*D_T^2*L$$

where D_T is the inside diameter in inches of the body tube compartment and **L** is the length in inches of the inside of that compartment. At this point we could combine these two equations to get one equation that calculates the hole size needed for a given D_T and **L**. However, it is not really a good idea to use just one hole. Multiple holes are better because they can help null out undesirable pressure effects caused by cross winds or unstable flight profiles. It is recommended that a minimum of three holes be used that are equally spaced around the body tube. (i.e. 120 degrees apart.) Four is also a good choice and is sometimes more convenient for physical layout.

Multiple holes can also be smaller than one hole so long as the total cross sectional area is the same. We can calculate the area of one hole from the following equation:

$$A_1 = (pi/4)*D_1^2$$

where A_1 is the area of one hole and D_1 is the diameter of the one hole. We can also calculate the area A_N of any number of **N** holes of diameter D_N from the following equation:

$$A_N = N*(pi/4)*D_N^2$$

Now by combining these two equations for area, we can calculate the diameter required for the **N** small holes that will give the same area as one big hole. The result is:

$$D_N = D_1/sqrt(N)$$

where **sqrt(N)** is the square root of **N**.

We now have everything we need to combine all these equations into one final equation:

$$D_N = D_T*sqrt((A_{ref}/V_{ref})*(L/N))$$

This equation is very useful because it directly calculates the diameter D_N of the small static port holes for a compartment with body tube inside diameter D_T, length **L**, and number of holes **N.** This equation can be used to directly calculate the proper hole sizes, especially in situations that do not lend themselves to the charts above.

We can also take this one step further since we know A_{ref} and V_{ref}. V_{ref} **=** 100 cubic inches and A_{ref} **= pi***(0.25/2)^2 = 0.04909 square inches.

$$D_N = 0.02216*D_T*sqrt(L/N)$$

Where D_N is the diameter of the small static port holes for a compartment with body tube inside diameter D_T, length **L**, and number of holes **N**. (All dimensions must be in inches for this equation.)