

Pitot Static tube duct surveys

If average duct velocities, or mass or volumetric flow rates are required, it is necessary to perform a Pitot traverse of the duct. This involves taking measurements at various positions across the duct. Before a traverse is conducted, it is necessary to select a suitable location to perform the survey. If possible, avoid traverses close to fans, dampers pipe bends, expansions etc. Try to survey at least 8 duct diameters downstream of the aforementioned elements and 2 duct diameters upstream of these elements. The survey is performed with the aid of Fig. 3. Either the Centroids of Equal Areas or Log-Tchebycheff point distribution may be used. A survey proceeds as follows:

1. Decide on the number of survey points and then mark these on the Pitot tube using a marker or adjustable spring clips (present on some Pitot Static tubes).
2. At the selected survey location, drill two perpendicular holes in the duct (for a round duct) or the desired number of holes for a rectangular duct, ensuring sufficient hole clearance to safely insert the Pitot Static tube.
3. Partially insert the temperature/RH sensor in an additional hole located close to the previously drilled holes.
4. Connect P_{abs} to a static pressure tap/ring close to the survey location, or use a "T" barb to connect to the static Pitot tube port, see sketch above.
5. Carefully insert the Pitot Static tube into the duct and position at the first traverse location. Ensure that the Pitot Static tube is aligned with the axis of the duct using the alignment guide on the tube as a reference.
6. Wait for the readout on the display to stabilize. If the readout continues to oscillate increase the damping. If the magnitude of the oscillations is greater than 25 %, then another measuring point should be considered as the results may not be representative.
7. When stabilized, record the desired reading(s).
8. Move the Pitot Static tube to the next traversing point and repeat 5 and 7 until the traverse is complete.
9. Repeat points 5-8 for the other traverse locations.

Once the traverse has been completed, the volumetric and mass flow rate through the duct can be calculated as follows:

Volumetric flow rate (Q):

$$Q = A_{duct} \frac{1}{n} \sum_{i=1}^n V_i$$

where:

A_{duct} is the duct cross sectional area.

n is the number of points (total number of points surveyed).

V_i is the indicated velocity at each measurement point.

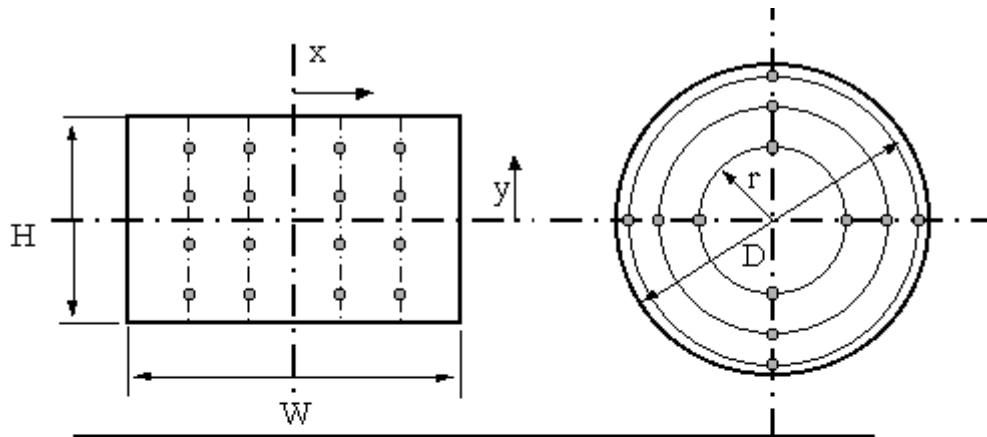
Thus, using a Centroids of Equal Areas or Log-Tchebycheff point distribution allows the velocity measurements to simply be summed and averaged.

Mass flow rate (m):

$$\dot{m} = \rho Q = A_{duct} \frac{1}{n} \sum_{i=1}^n \rho V_i$$

where: ρ is the density of the gas in the duct.

NOTE: Assuming fully developed turbulent flow with low air swirl (rotation), i.e. after a long section of duct, the average duct velocity may be estimated using a single Pitot reading at the centre of the duct. The average velocity is then approximately 0.9 of this reading with an accuracy of $\pm 5\%$.



Rectangular ducts – Centroids of Equal Areas

Rows or Points/Row	Distance from Center-line, x/W or y/H			
4	± 0.125	± 0.375		
5	0	± 0.2	± 0.4	
6	± 0.083	± 0.25	± 0.417	
7	0	± 0.143	± 0.286	± 0.429

Circular ducts – Centroids of Equal Areas

Points/Radius	Distance from Center, r/D					
3	0.204	0.353	0.457			
4	0.177	0.306	0.395	0.468		
5	0.158	0.274	0.354	0.418	0.474	
6	0.144	0.25	0.323	0.382	0.433	0.479

Rectangular ducts – Log-Tchebycheff

Rows or Points/Row	Distance from Center-line, x/W or y/H			
5	0	± 0.212	± 0.426	
6	± 0.063	± 0.265	± 0.439	
7	0	± 0.134	± 0.297	± 0.447

Circular ducts – Log-Tchebycheff

Points/Radius	Distance from Center, r/D					
3	0.188	0.362	0.468			
4	0.166	0.306	0.4	0.476		
5	0.143	0.295	0.345	0.424	0.481	

Fig. 1 Traverse point for rectangular and circular ducts. Either Centroids of Equal Areas or Log-Tchebycheff point distributions can be used.