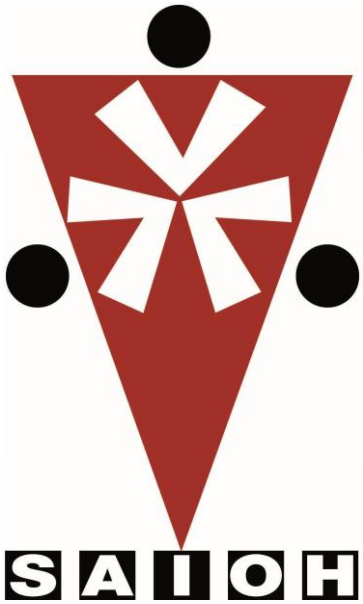


SAIOH Tutorial

Ventilation 1 – pressures and basic air flow calculations

Acknowledgement

- This tutorial was provided by SAIOH as an assessment support aid for prospective candidates.
- The tutorial is free to use and share for learning and knowledge improvement for candidates preparing to sit SAIOH registration assessments.
- Please ensure that you acknowledge SAIOH as the author and source of this material.

Pressure

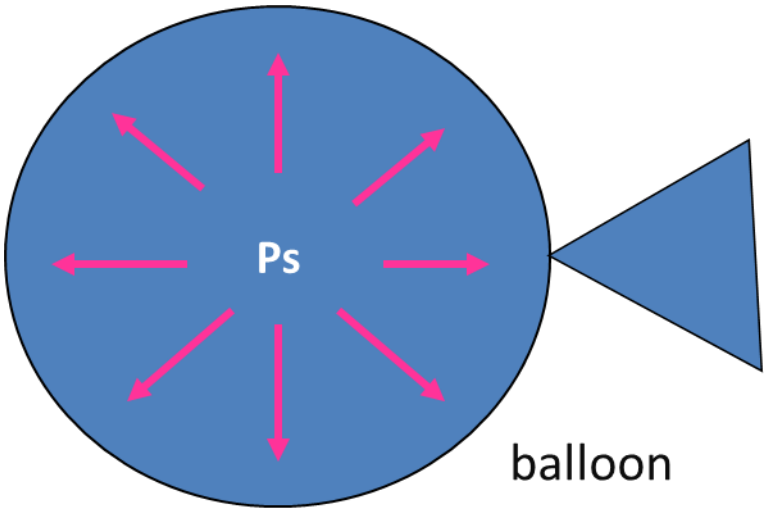
- For air to flow there must be a pressure difference and air will flow from the higher pressure to the lower pressure
- Pressure is considered to have two forms:
  - static pressure (P_s)
  - velocity pressure (P_v)

  With the sum of these being total pressure (P_t).

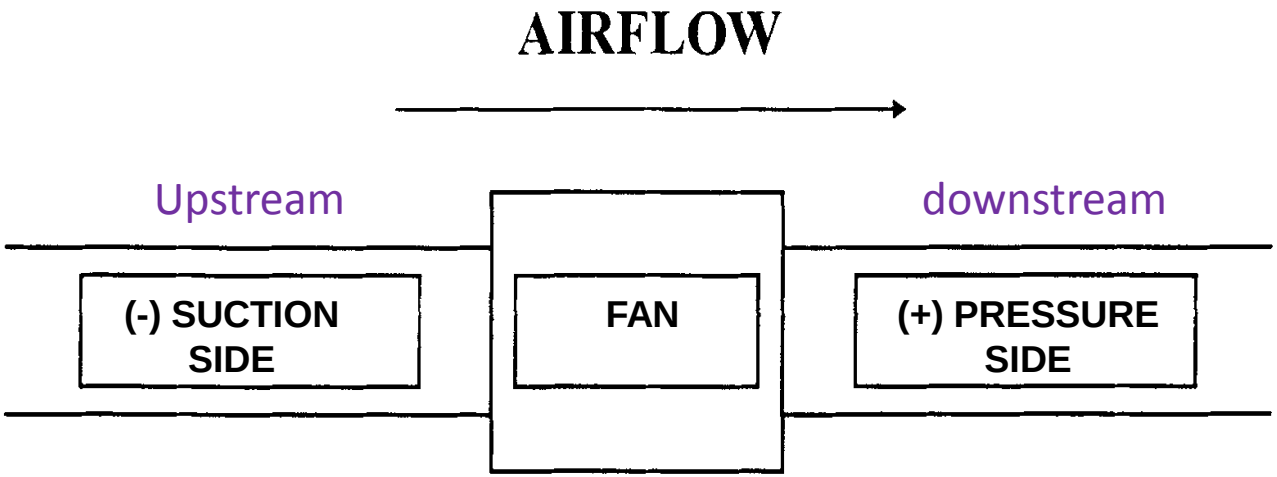
Static Pressure

- Static pressure is defined as the pressure exerted in all directions by a fluid that is stationary

- If the fluid is in motion (as is the case in a ventilation system), static pressure is measured at 90° to the direction of the flow so as to eliminate the influence of movement (ie: velocity)



Static Pressure (Cont)



Can be both positive and negative depending if it is measured on the discharge or suction side of a fan

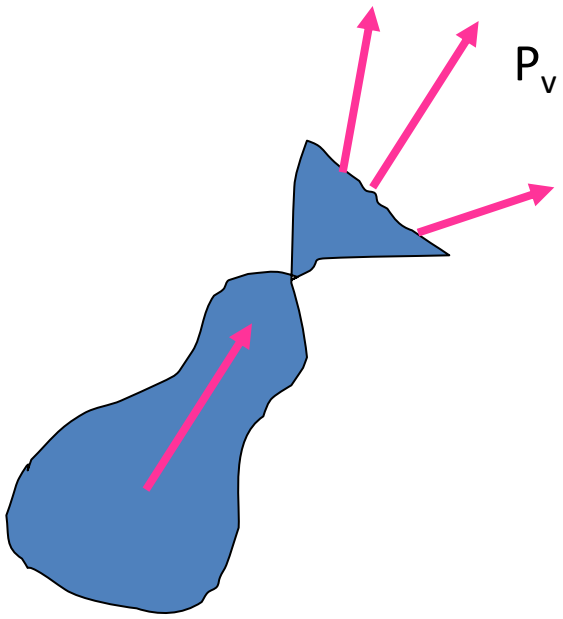
Velocity Pressure

- Defined as that pressure required to accelerate air from zero velocity to some velocity and is proportional to the kinetic energy of the air stream

- In simple terms, velocity pressure is the kinetic energy generated in a ventilation system as a result of air movement

Velocity Pressure

- Is the pressure due to air moving
- acts in the direction of the air movement/ flow
- Always positive



Velocity Pressure (cont)

$$\mathbf{P_v} = \boldsymbol{\rho} \frac{\mathbf{v^2}}{\mathbf{2}}$$

ρ = Density of air (kgm^{-3})

v = Air velocity ms^{-1}

P_v = Velocity pressure (Pa ie Nm^{-2})

Velocity Pressure (cont)

If standard temperature and pressure conditions are in existence, i.e.:

$\rho = 1.2 \text{ kg m}^{-3}$

Then

$P_v = 0.6 v^2$

Total Pressure - P_t

- Algebraic sum of static and velocity pressure at any point
- May be +ive or –ive depending on flow direction

$$P_t = P_s + P_v$$

P_t = total pressure

P_s = Static pressure

P_v = Velocity pressure

All in Pascal's, Pa (Nm^{-2})

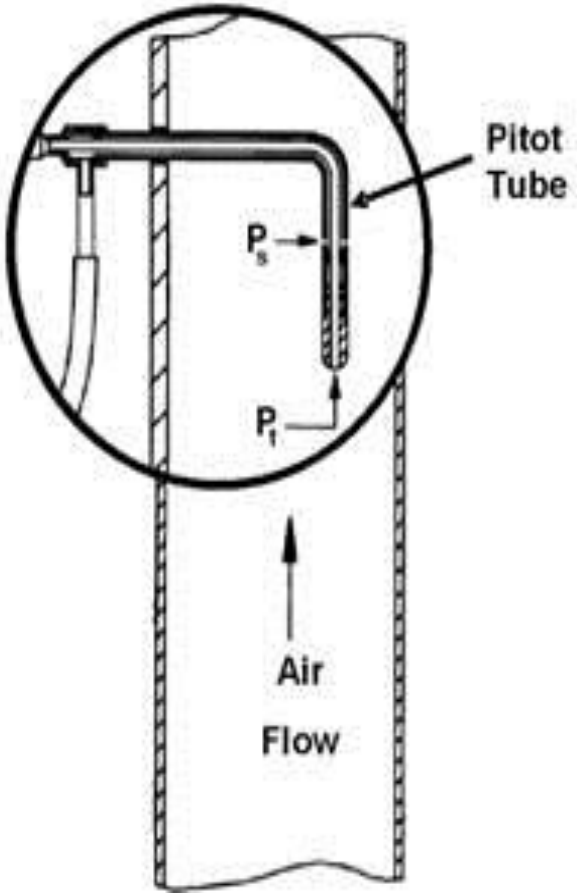
Relationship is: $P_t = P_s + P_v$

Velocity pressure = P_v

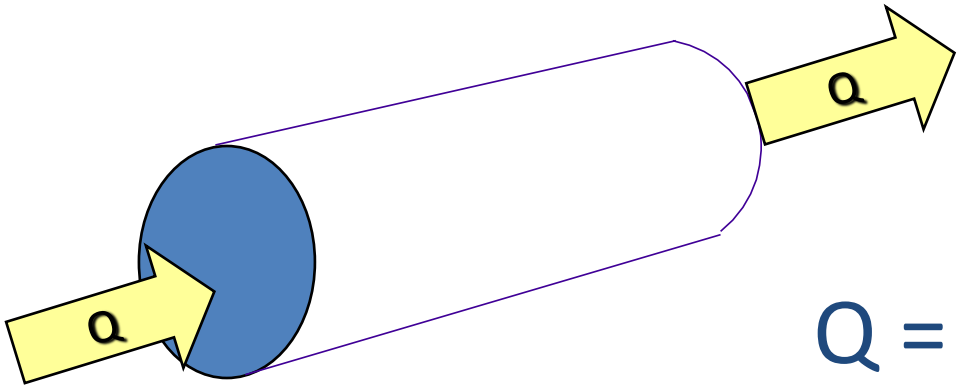
Static pressure = P_s

Total pressure = P_t

$$P_t = P_s + P_v$$



Volume and Mass



$$Q = VA$$

When a quantity of air is moving within a ventilation system the volumetric flow rate is a product of the velocity of the air and the cross-sectional area of the system through which it is flowing.

Volume flow

- The volume of air passing through a duct is calculated by:

$$Q = V \times A$$

Where:

- Q = Quantity of air flow in m^3s^{-1}
- V = Air velocity measure across the duct in ms^{-1}
- A = cross sectional (face) area of the dust (or hood) in m^2

Calculating the area of round ducts

$$A = \pi r^2$$

Example: a duct is measured at 250mm diameter, what is its area in m^2

Step 1 – convert mm to m = 0.25m diameter

Step 2 – calculate the radius = 0.25 x 0.5 = 0.125

$$A = \pi\ 0.125^2$$

Using the calculator press the following buttons:

0.125 [x^2] x [π] = 0.049 m^2

Calculating the area of round ducts

$$A = \pi r^2$$

Calculate the cross sectional areas (m^2) for the following size round ducts:

100mm	125mm	150mm	200mm	225mm	275mm	300mm

Calculating the area of Square or rectangular ducts

multiply the width by the height (remember to convert units to m)

$$A = W \times H \text{ (in m)}$$

Calculate the cross sectional area (m^2) for a duct of W 200mm and H 300mm

$$A = 0.20 \times 0.30 = 0.06\ m^2$$

Calculating the area of Square or rectangular ducts

multiply the width by the height (remember to convert units to m)

Calculate the cross sectional area (m^2) for the following ducts

W 100mm H 300mm	W 400mm H 200mm	W 600mm H 300mm	W 1500mm H 1000mm

Calculating volume flow rates (m^3s^{-1})

$$Q = V \times A$$

The average velocity of air passing through a 150 mm diameter duct was measured at 12 ms^{-1}, what is the volume flow rate?

Step 1 calculate A = 0.018

Step 2 calculate $Q = 12 \times 0.018 = 0.22 m^3s^{-1}$

Calculating volume flow rates (m^3s^{-1})

Calculate the volume flow rates for the following situations:

17.5 ms^{-1} in a 250 mm diameter duct = _____

22.2 ms^{-1} in a 125 mm diameter duct = _____

13.7 ms^{-1} in a rectangular duct 125 x 250mm = _____

17.5 ms^{-1} in a rectangular duct 200 x 400mm = _____

Calculating Velocity

- If Q = V x A - then it is possible to calculate velocity from a know quantity of air flowing through a system
- Rearrange the equation for this calculation?

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$$V = \frac{Q}{A}$$

Exercise 1

If the velocity inside a circular duct with a diameter of 0.5 metre is $9.1ms^{-1}$, what is the volume flow?

Exercise 2

The face velocity at a booth (2 x 1.5 m) is 0.5 ms^{-1} and the duct from the booth is 0.4 m in diameter

- What is the volume flow through the system?
- What is the velocity in the duct?

Exercise 2

1st step calculate the areas of the booth and the duct:

for the booth A =

and the duct A =

Exercise 2 - Answer

What is the volume flow through the system (hood)?

$$Q = vA$$

What is the velocity in the duct?

$$v = Q/A$$