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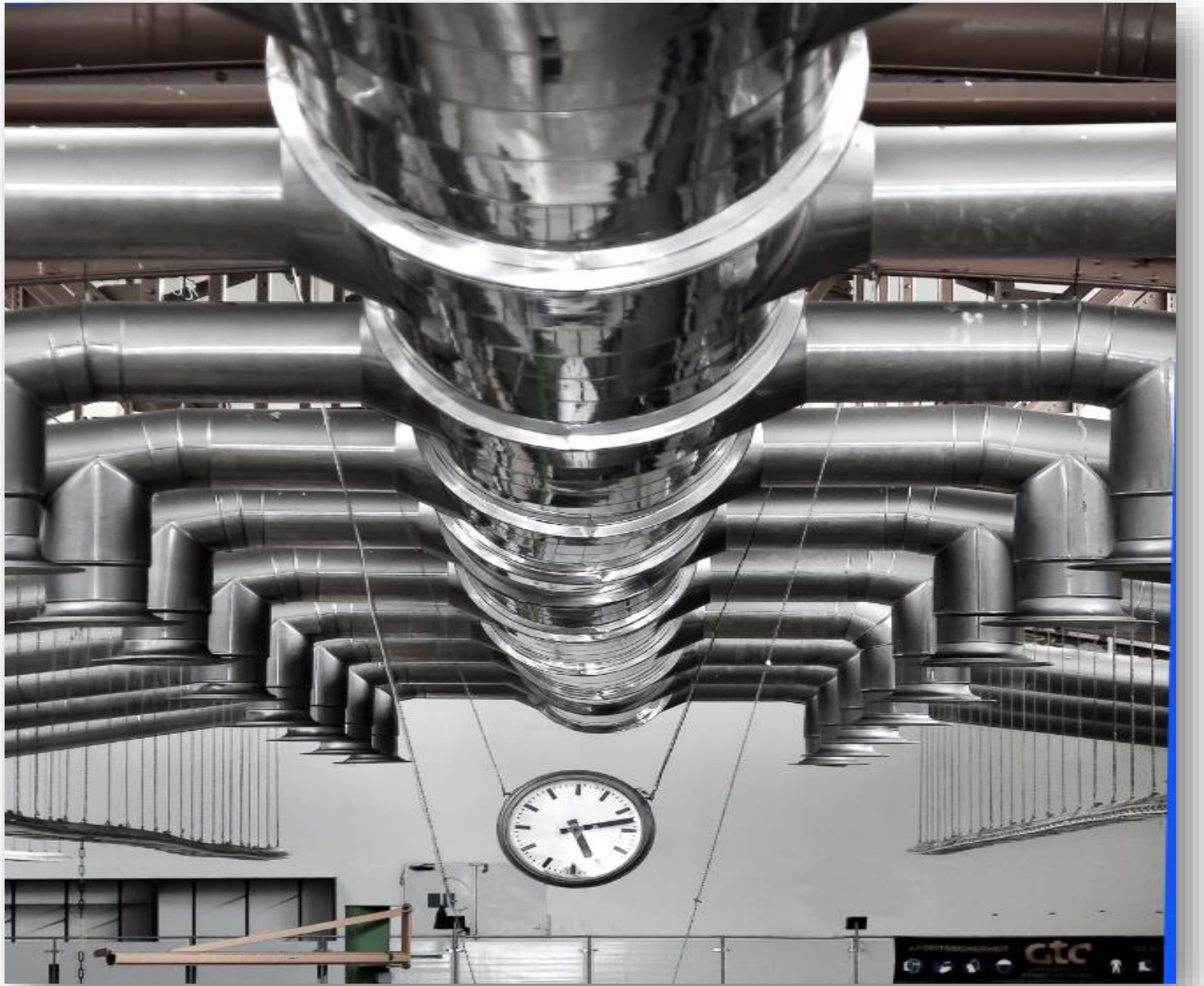
Brief Introduction of the Principles Ventilation



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Agenda

What is Air
What is ventilation
Natural – Mechanical
Positive – Negative – Balanced
Ventilation Systems
Types of Fans
Components
Air Changes
Questions

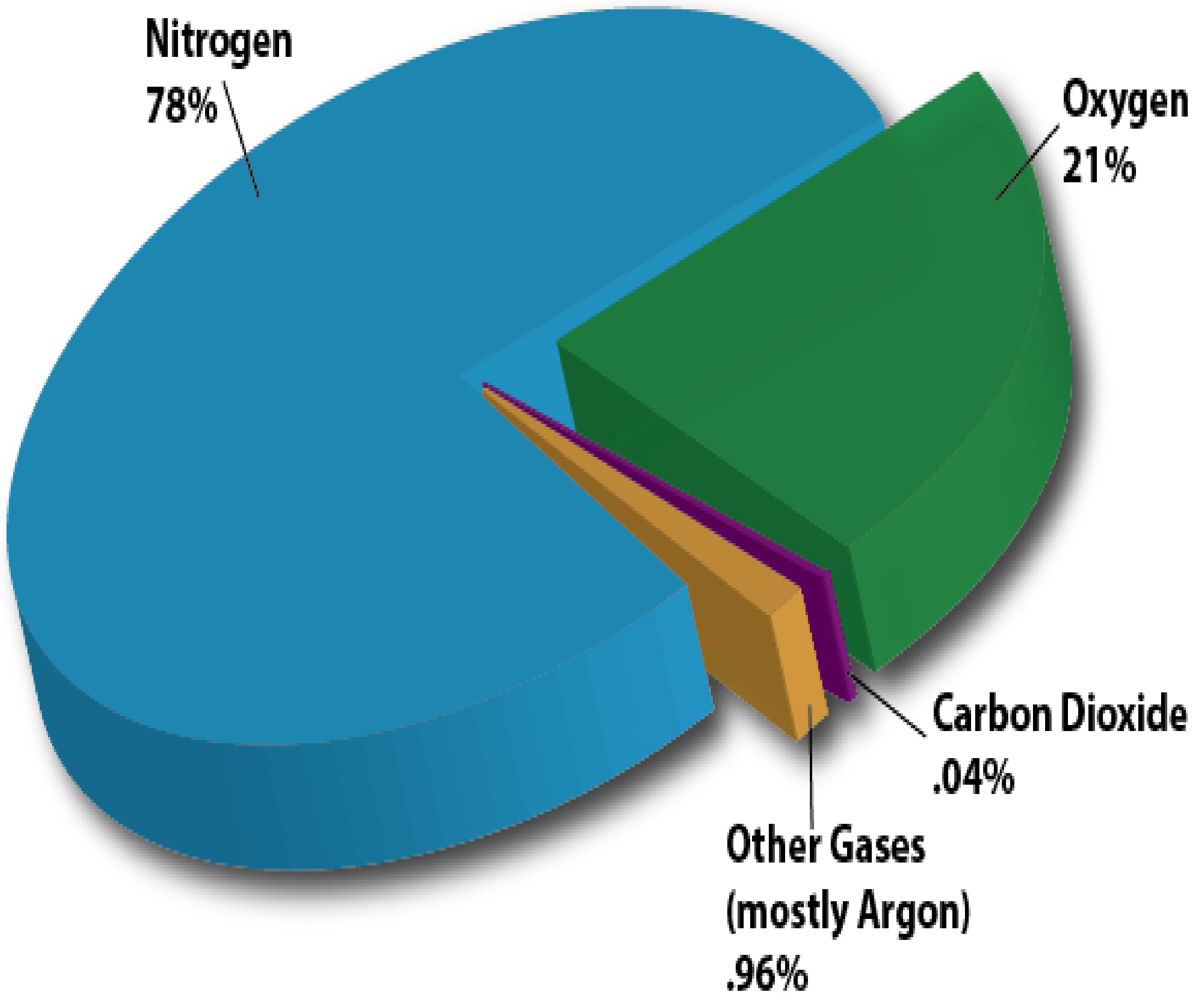
What is air ?

Air is a mixture of gases that surrounds the Earth.

99% of air is made up of oxygen and nitrogen.

People and other animals need oxygen to live.

Carbon dioxide, a gas that plants depend on, makes up less than .04 percent.



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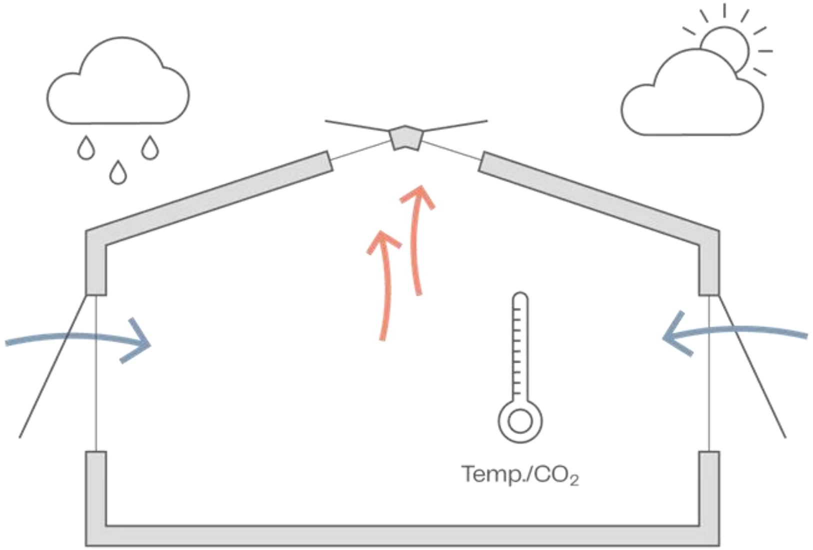
What do we breathe?

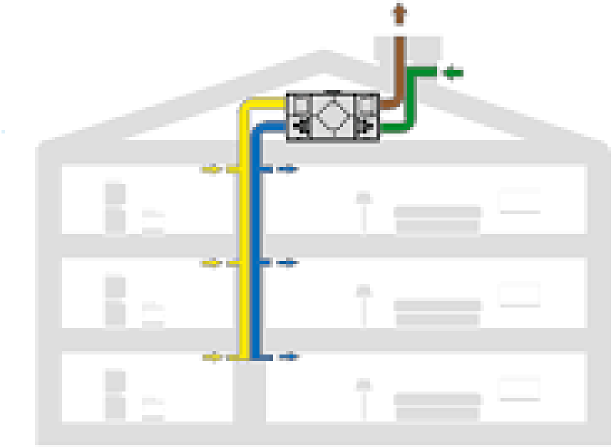
Gas	Air breathed in	Air breathed out
carbon dioxide	0.04%	4%
oxygen	21%	15%
nitrogen	78%	78%
water vapour	variable	variable but a lot more

What is ventilation?

Ventilation moves, and distributes, outdoor air into a building or a room.

All the fans, ductwork, grilles and ventilation equipment make up a "ventilation system".





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What is the purpose?

The general purpose of ventilation in buildings is to provide healthy air for breathing.

Why do we need it?

Good ventilation is essential in any building.

Without proper ventilation, air becomes stale and stagnant, which can cause illness, damage to buildings and contents.

Installing a proper ventilation system is essential for air circulation that produces clean air.

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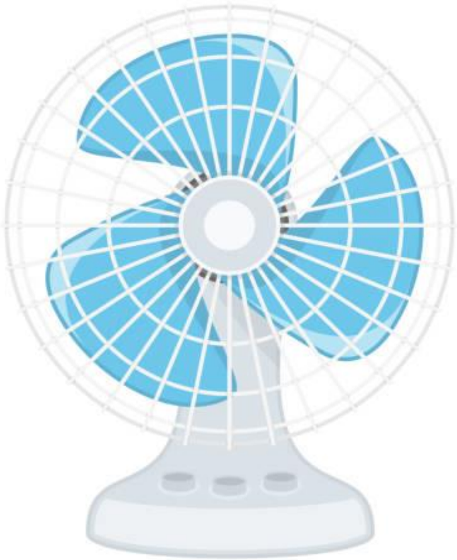
Types of Ventilation:

Natural

Mechanical



Natural Ventilation

What is Natural Ventilation?

In the case of natural ventilation, the air movement is caused by two factors:

- The difference between indoor and outdoor temperature
- Wind

As both of these factors are directly dependent on the external climate, the system is considered to be non-controllable.

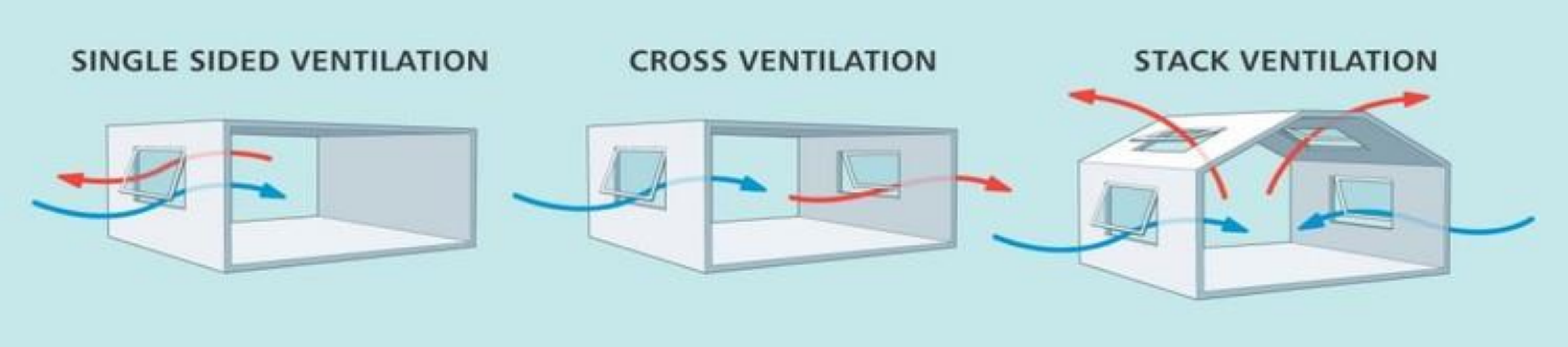
Natural Ventilation

How does it work?

Natural ventilation uses forces of nature (e.g. winds and thermal buoyancy force) to drive outdoor air through purpose-built, building envelope openings.

Purpose-built openings include windows, doors, solar chimneys, wind towers and trickle ventilators.

This natural ventilation of buildings depends on climate, building design and human behaviour.



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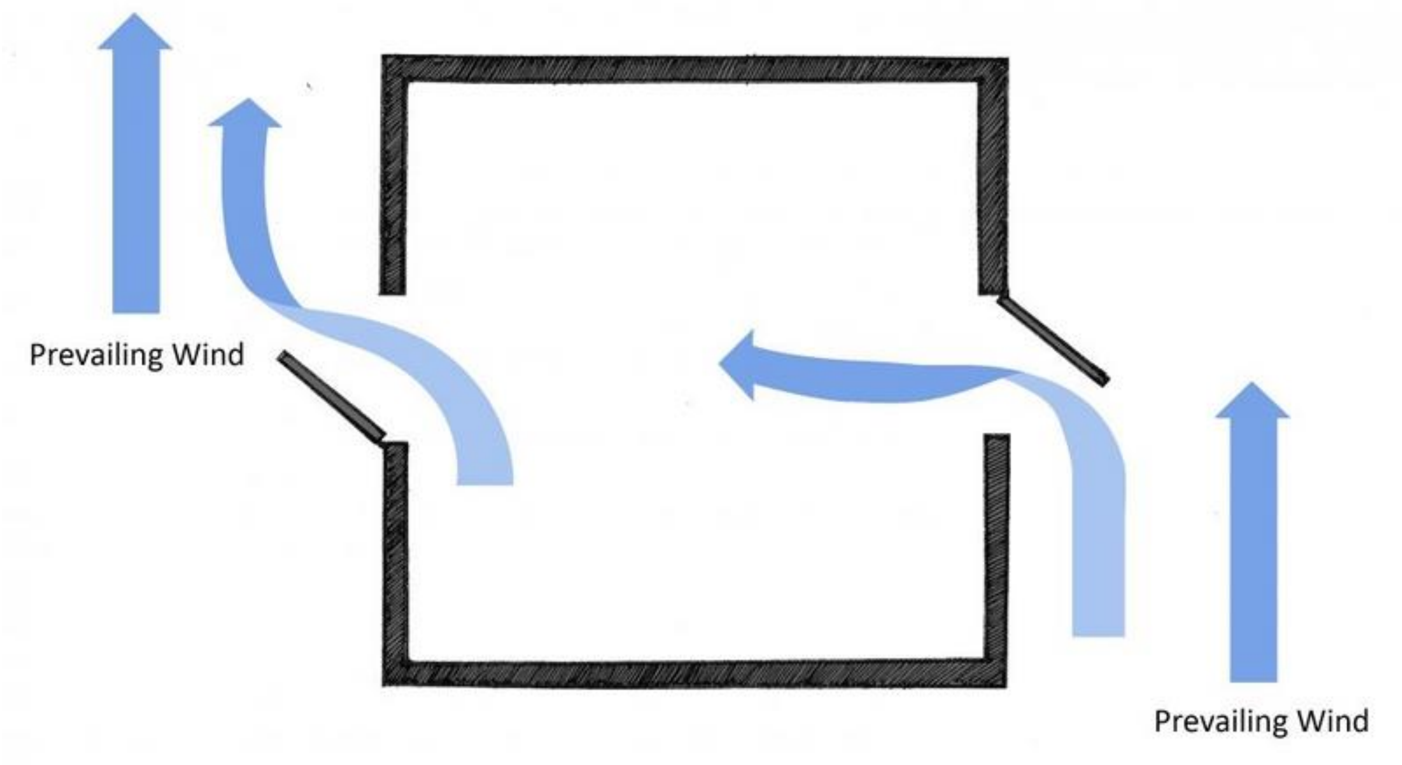
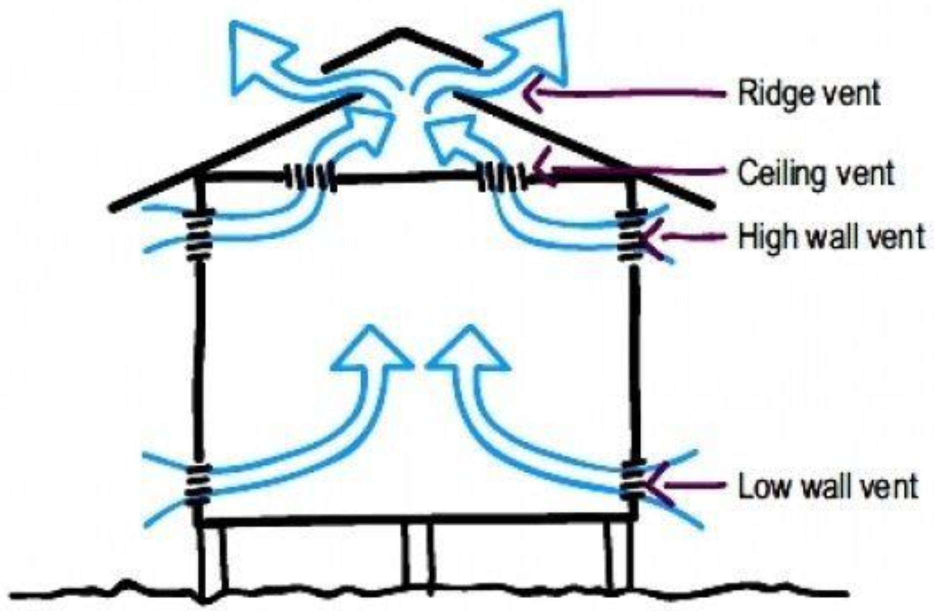
Natural Ventilation





variety of ways to increase convection in the house and roof space.

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Mechanical Ventilation

What is Mechanical Ventilation?

Mechanical ventilation is driven by mechanical fans.

Fans can either be installed directly in windows or walls, or installed in air ducts for supplying air into, or exhausting air from a room.

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Types of Mechanical Ventilation

The type of mechanical ventilation used can depend on climate.

For example, in warm and humid climates, infiltration may need to be minimised or prevented to reduce condensation.

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In these cases, a positive pressure mechanical ventilation system is often used in which fresh outside air is blown into the building by inlet fans, creating a higher internal pressure than the outside air. (Supply)

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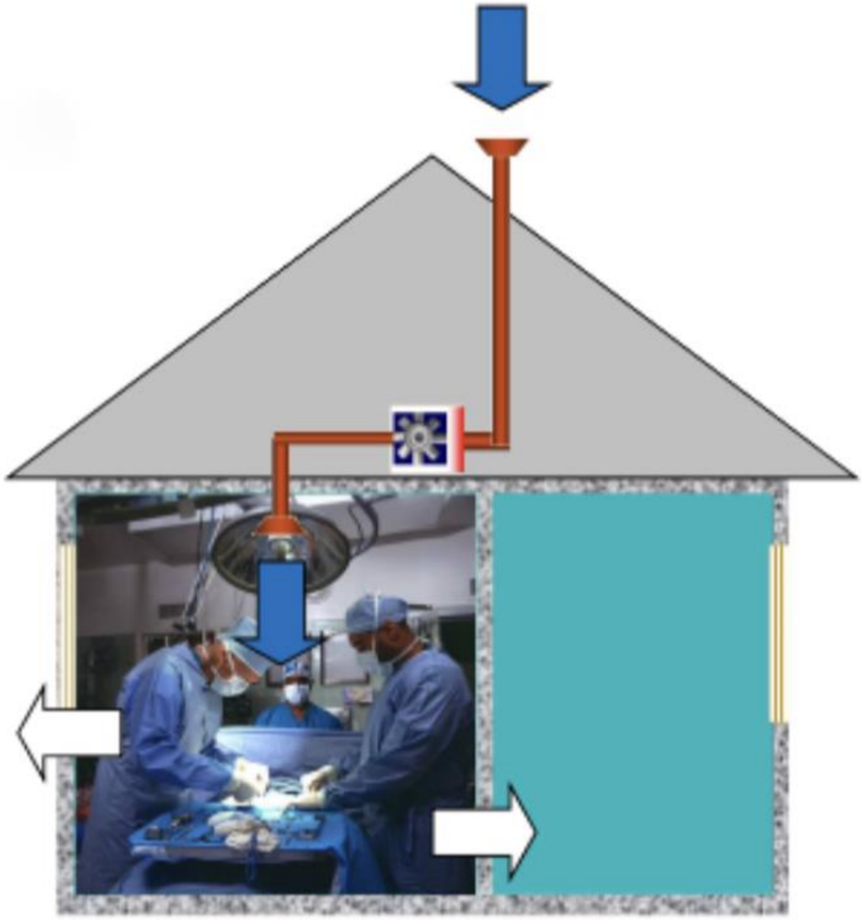
A negative pressure (vacuum) ventilation can be used for a room with locally generated pollutants, such as a bathroom, toilet or kitchen, the negative pressure system is often used. (Extract)

Types of Mechanical Ventilation



Positive Pressure System

Positive pressure rooms maintain a higher pressure inside the treated area than that of the surrounding environment.

This means air can leave the room without circulating back in.

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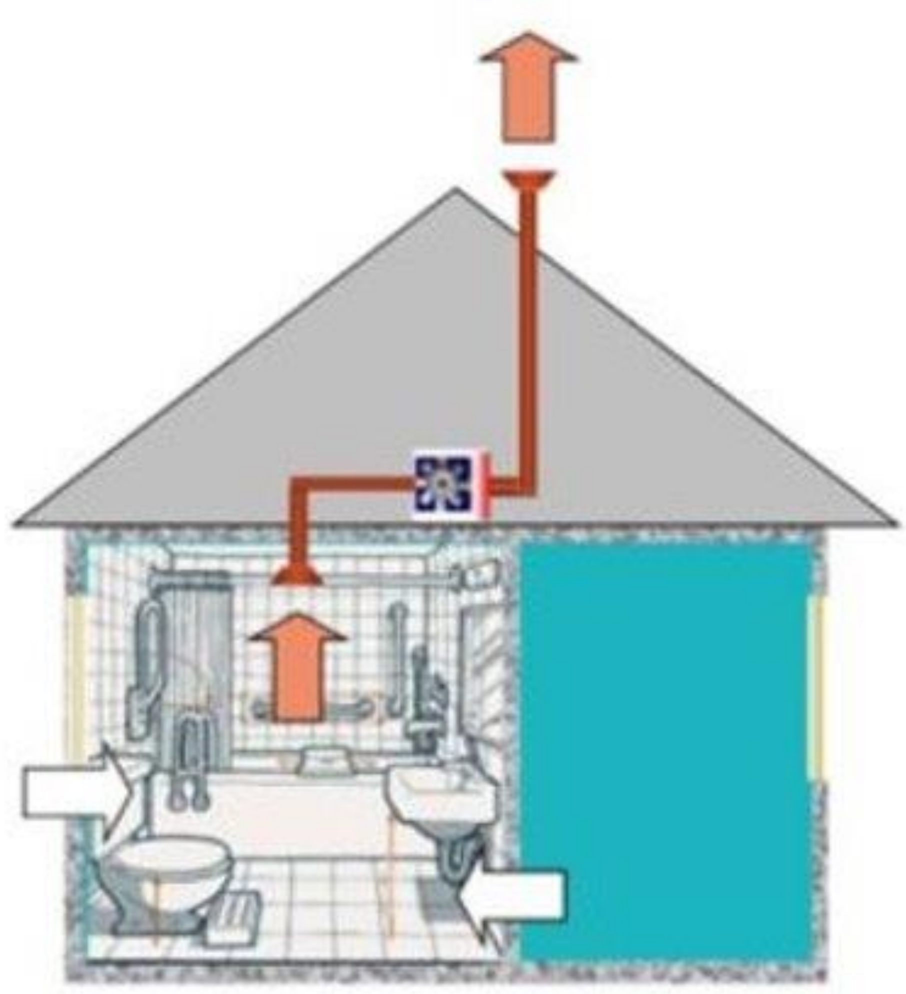
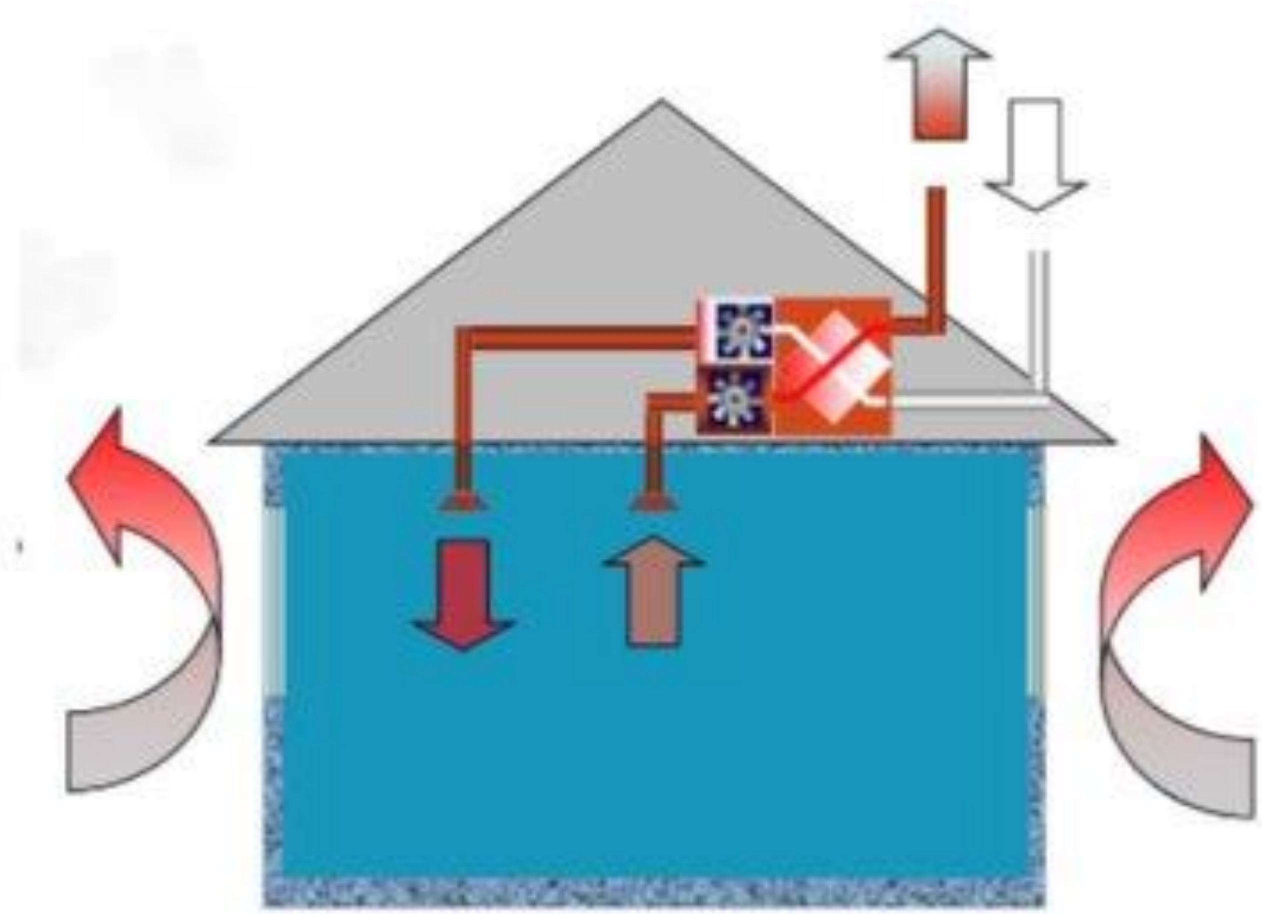
Types of Mechanical Ventilation



Negative Pressure System

A vacuum system (negative pressure system), in which stale internal air is extracted from the building by an exhaust fan, creating lower pressure inside the building than the outside air.

Types of Mechanical Ventilation



Balanced Pressure System

A balanced system that uses both inlet and extract fans, maintaining the internal air pressure at a similar level to the outside air and so reducing air infiltration and draughts.

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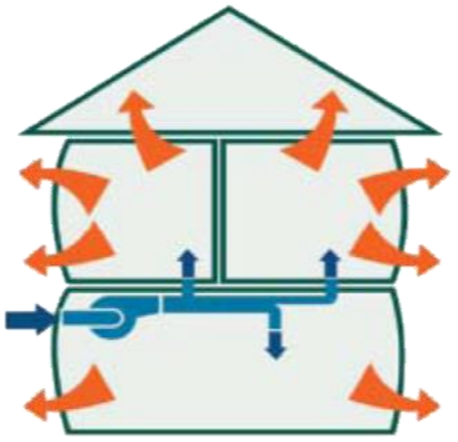
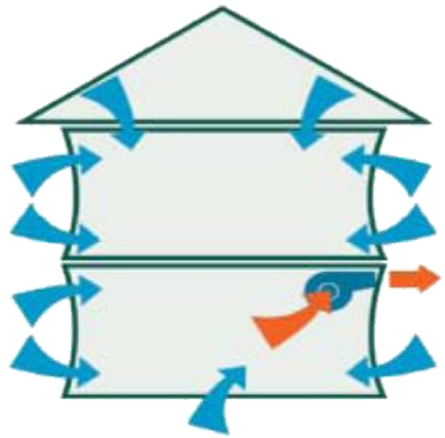
Types of Mechanical Ventilation



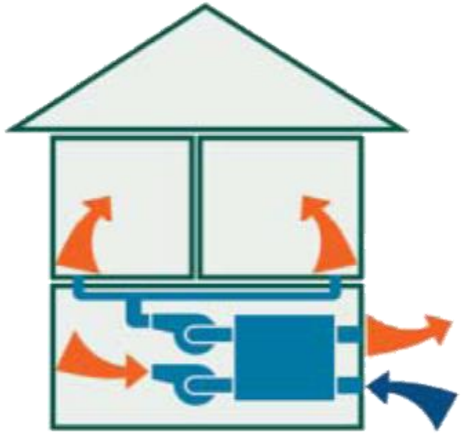
Positive air pressure

- Pushes hot and/or humid air into walls and insulation; condensation can lead to mold, mildew and rot
- Heat loss



Negative air pressure

- Infiltration of unconditioned air increases risks of mold and higher energy costs
- Potential backdraft from combustion appliances



Equal air pressure

- Supply airflow (CFM) is equal to stale air exhaust
- Balancing is required on all units unless specified otherwise

In a positive pressure system, the room is in positive pressure and the room air is leaked out through envelope leakages or other openings.

In a negative pressure system, the room is in negative pressure, and the room air is compensated by "sucking" air from outside.

A balanced system, that uses both inlet and extract fans, maintains the internal air pressure at a similar level to the outside air, therefore reducing air infiltration and draughts.

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Circulation System (Ceiling Fan)

A ceiling fan does not actually lower the overall temperature in a room, but it can definitely make a space feel cooler by redistributing air.

Ceiling fans primarily work through something called a wind chill effect, hot air rises, while cool air settles in the lower part of a room.

A ceiling fan can help to pull cold air higher up, so it circulates around your face instead of your feet.

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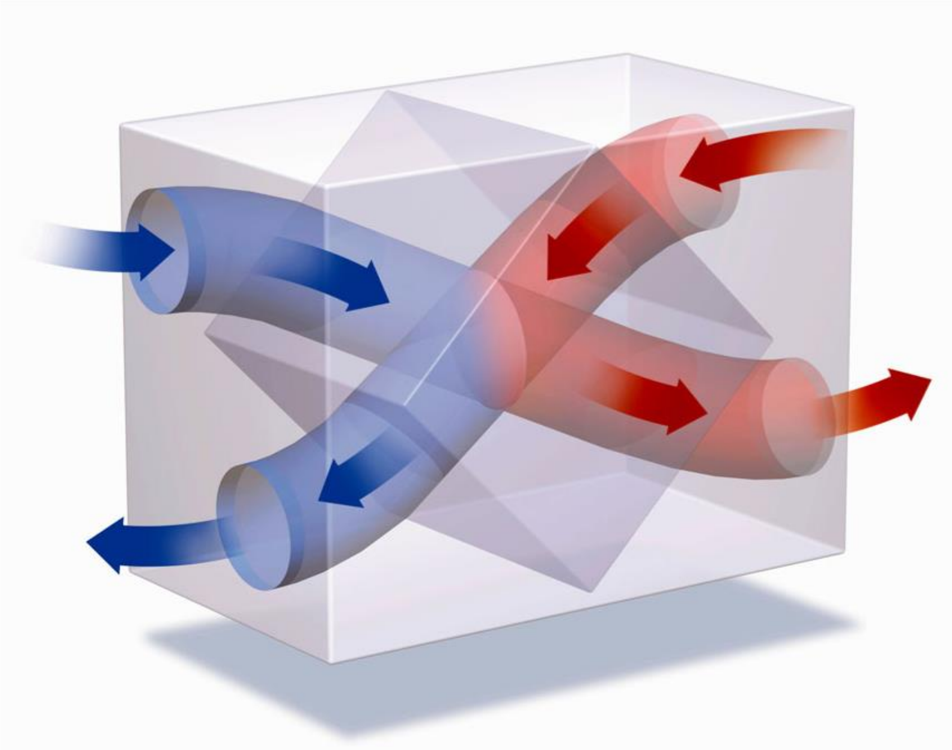
Heat Recovery System - MVHR

What is Heat Recovery?

Heat recovery is a process of continuously preheating incoming cool supply air by warming it with the outgoing exhaust air. Warm air is not simply exhausted too outside. Highly efficient heat exchangers transfer a larger percentage of heat energy to incoming supply air.



How is it used?

A Mechanical Heat Recovery Ventilation (MVHR) system offers a solution by bringing fresh air into all habitable areas without letting the heat escape.

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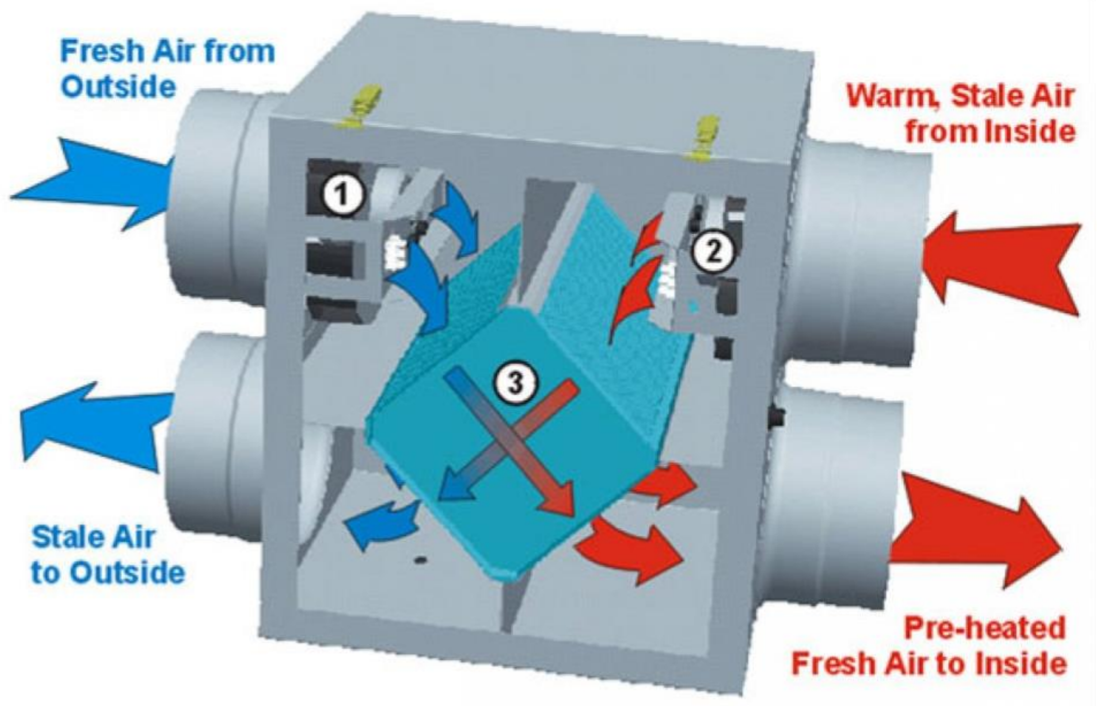
Heat Recovery System

How does it work?

Stale air contaminated with humidity, toxins and smells is extracted from grilles in toilets and wet rooms. Areas such as bathrooms, en-suites, utility rooms and kitchens allow a constant or demand oriented air flow volume to be extracted.

Fresh air is fed directly from outside into the ventilation system initially through a filter, then the heat taken from the extracted air is used to warm the fresh filtered air in the heat exchanger and then enters the ducting system.

By continuously supplying pre-heated air into living areas and extracting contaminated air from wet rooms, you create a whole-house ventilation system. Air is allowed to circulate from supply air rooms to rooms with extract via undercuts on all internal doors and / or by the use of transfer grilles.



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BSEHV05 - J4FE 04
Install and test industrial and commercial heating and ventilating ductwork systems

Ductwork Systems

- supply, extract and re-circulation
- local exhaust ventilation
- low, medium and high-pressure air
- kitchen extract
- fire protection

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Introduction to Fans

All fans essentially serve the same purpose.

All are powered machines (usually powered by electric motors) that create air flow by using a rotating arrangement of vanes or blades and direct the air in a chosen direction.

Fans have a wide variety of uses, including climate control, vehicle/machinery cooling, ventilation, fume extraction, dust removal, provision of draft and drying.

We are going to look at three different types of fans: axial flow fans, centrifugal fans and crossflow fans but all will have similar key components:

Casing –the stationary components that guide the air flow through the fan

Impeller –the part of the fan that rotates, creating air movement

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Axial Flow Fan

- Axial-flow fans date back to the times of early European windmills, first seen in the Middle Ages.
- They have cantilevered blades, i.e. supported at one end, that force air to move parallel to the axis about which the blades rotate(therefore in an axial direction), for example, ceiling, car and computer fans and wind tunnels.
- Axial fans produce a pressure difference, causing the air to flow through the fan. The performance of the fan, is determined by a number of factors including the number and shape of blades.
- Some blades may have a ‘twist’, whereby the angle of the blade increase from tip to root. As the angle increases the flow rate and impeller power demand both increase.

Axial Flow Fan

The oldest type of fan, axial-flow fans are perhaps the most common, used in a multitude of places including (but not limited to):

- Snow machines
- Hovercrafts
- Ceiling fans
- Upright rotating fans
- Extractor fans
- Wind tunnels
- Car fans
- Computer fans
- Well pumps
- Generators
- Air compressors
- Fume-hood/ welding-fume exhausts

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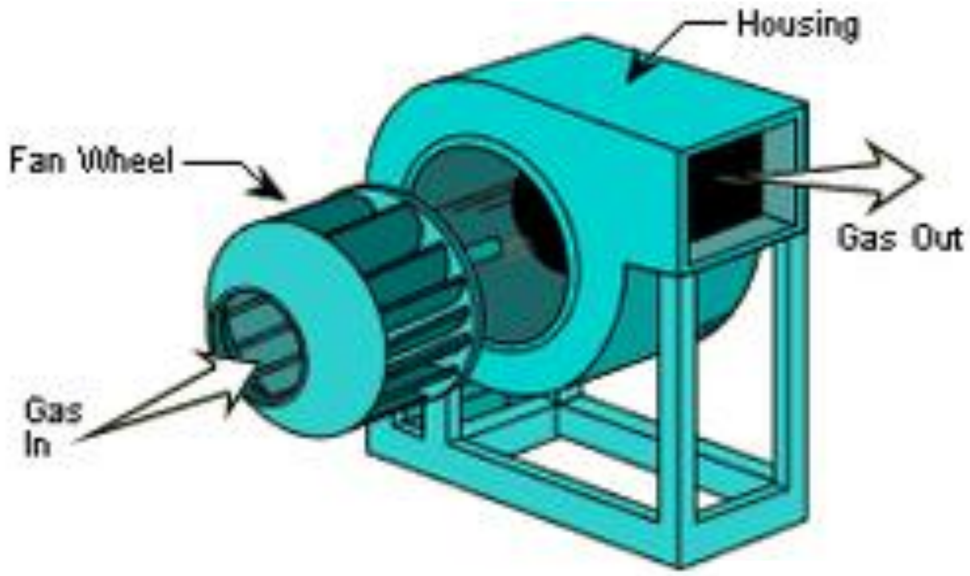
Centrifugal Fan

Invented in 1832 by Russian military engineer Lieutenant General Alexander Sablukov, the centrifugal fan's primary difference, compared with the axial flow fan, is that the air is blown out at a right angle to the direction of the air intake.

The airflow created by centrifugal fans is directed through a system of ducts or tubes, helping to create a higher pressure than axial flow fans, plus a steadier flow of air. They therefore require a higher power input than axial flow fans.

The image to the right shows the basic components of a centrifugal fan; gas (air) enters the fan via the fan wheel, encased in a ducted housing. The fan wheel then rotates, forcing the air out of the housing, at a 90° angle to which it originally entered.



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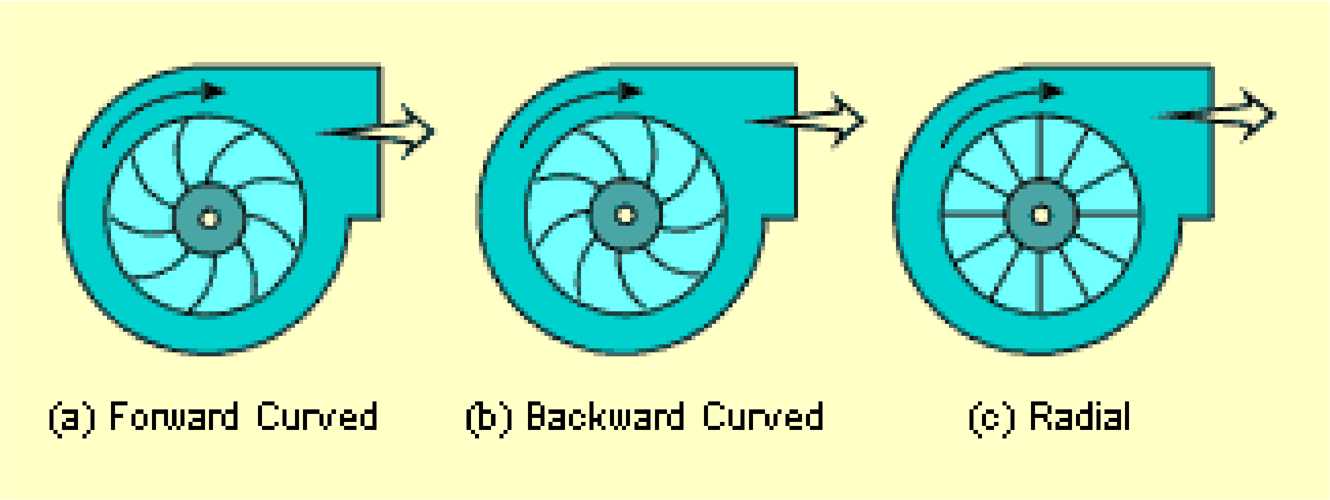
Centrifugal Fan

The fan blades on the fan wheel can be arranged in one of three different ways: forward-curved/inclined, backward-curved/inclined or radial.



Forward curved / inclined blades (a) are curved / angled in the direction of the wheel rotation. They are most used in clean-air systems as they are particularly sensitive to particulates found in the air. They are the least noisy centrifugal fan.

Backward curved / inclined blades (b) curve/angle against the direction of rotation. These are less sensitive to particulates and as such are used where gas streams have low-moderate particulates. They are able to run at higher speeds and are often used in high pressure, medium flow applications. They are more energy efficient to run than radial blades (c).

Radial blades (c) extend straight out from the centre of the fan wheel. They are the least sensitive to particulates and so are used where the loading is high. They usually have a greater noise output and work at high speeds and pressures and low volumes and are the least efficient. Perhaps the most recognisable use is in vacuum cleaners.

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Crossflow Fan

Crossflow fans are probably the most common fans found in the HVAC industry.

They create a huge flow of air using a long, cylindrical impeller that disperses the air out through the front opening.

Blade are generally longer than those in axial and centrifugal fans.

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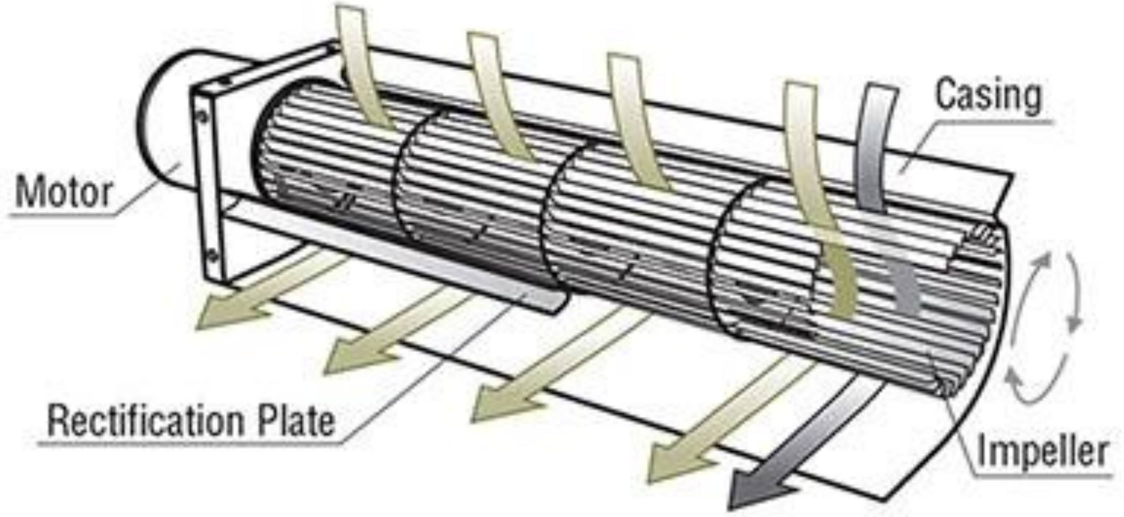
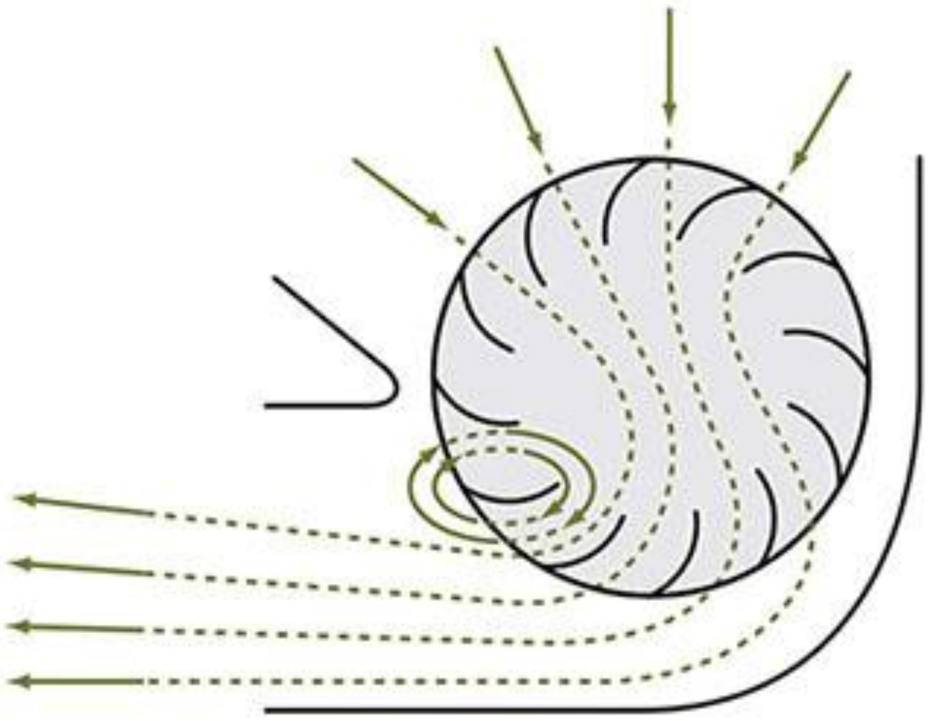
Crossflow Fan

Crossflow fans create a cylindrical vortex of spinning air with the axis of the cylinder, axis of the fan and the impeller blades all parallel to one another.



Air is pulled into the fan, meeting the blades at the same angle where it is then spun around smoothly and at high speed. It leaves the fan between the vortex (top) wall and the rear (bottom) wall.



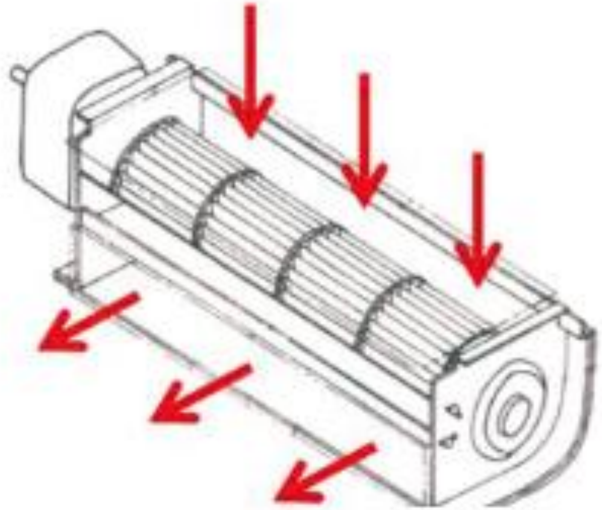
The ends of the impeller are solid end plates and prevent air moving laterally across the impeller, instead forcing it through the impeller and out of the fan.

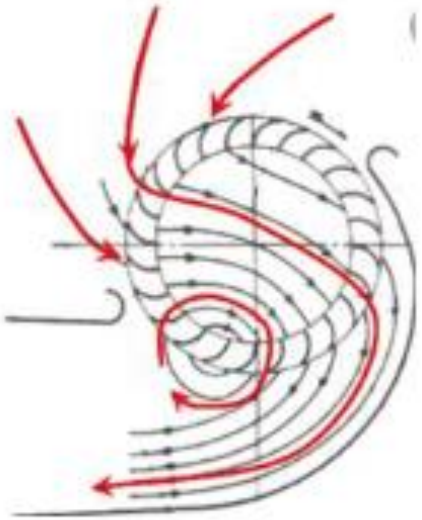
Crossflow Fan

Advantages of crossflow fans in the HVAC arena are that they are small in size and, where necessary, can have a long, shallow font to diffuse the air.

They are energy efficient, quiet and provide a long throw of air.

They are found in a number of systems including aircraft wings, air conditioners, fan coil units, vehicle ventilation systems and photocopiers.





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Fan Type	Efficiency %		Advantages	Disadvantages	Applications
	Static	Total			
Axial Flow (without guide vanes)	50-65	50-75	· Very compact, straight-through flow · Install in any position in ducting	· Hight tip speed · High noise level · Low pressure development	Low pressure atmospheric applications
Axial Flow (with guide vanes)	65-75	65-85	· Straight-thorugh flow · Suitable for vertical axis	· Hight tip speed · High noise level · Low pressure development (though less than without guide vanes)	Low pressure atmospheric applications & large ventilation schemes (e.g. tunnel)
Centrifugal - Forward Curved	45-60	45-70	· Low peripheral speed · Quiet · Compact	· Increased power = large motor margin · Unsuitable for air-borne particulates	All low- & medium-pressure atmospheric air & ventilation plants
Centrifugal - Backward Curved	65-75	65-85	· Good efficiency · Non-overloading power characteristic	· Hight tip speed · High noise level	Medium- & high-pressure applications
Centrifugal - Radial	45-55	45-70	· Strong, simple impeller · Least likely to clog - suitable for air-borne particulates · Easily cleaned & repaired	· Low efficiency · Increased power requirement · High noise level	Material transport systems & anywhere dust burden is high
Crossflow	-	45-50	· Straight across flow · Long, narrow throw / discharge · Small in size · Quiet	· Low pressure development	· Fan coil units · Room conditioners · Domestic heaters

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Fan Coil Unit - FCU

What is it?

A Fan Coil Unit (FCU) is a simple device consisting of a heating and/or cooling heat exchanger or 'coil' and fan. It is part of an HVAC system found in residential, commercial, and industrial buildings.

What is it used for?

Typically, an FCU is not connected to ductwork, and is used to control the temperature in the space where it is installed, or serve multiple spaces. It is controlled either by a manual on/off switch or by a thermostat.

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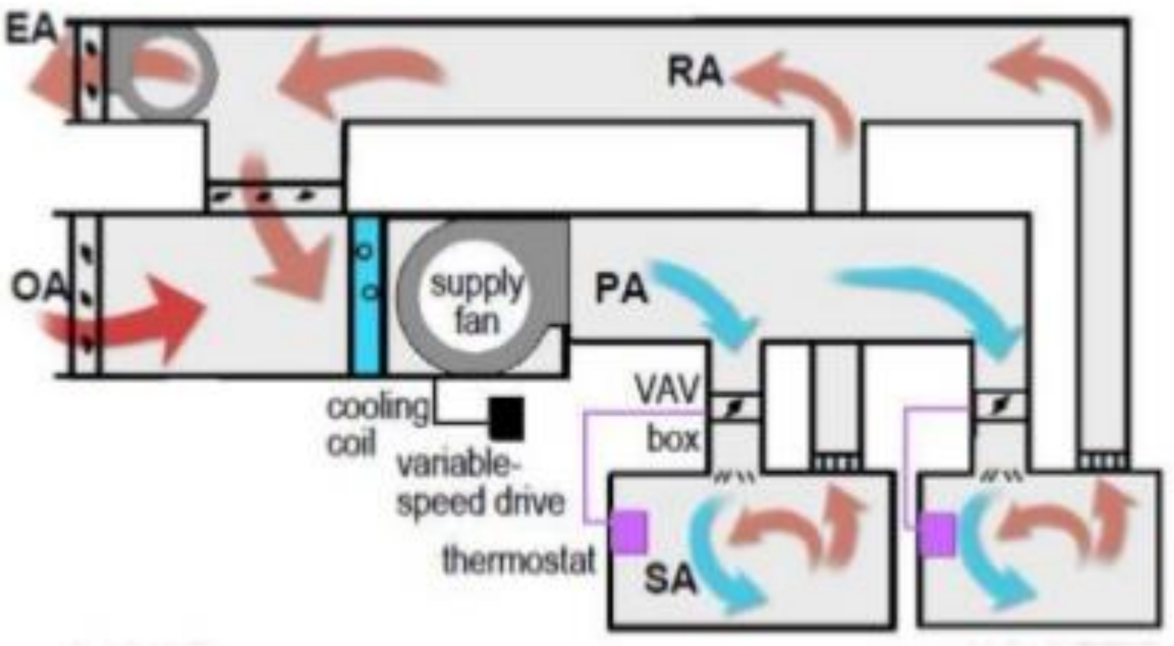
Variable Air Volume - VAV

What is it?

Variable Air Volume (VAV) is a type of heating, ventilating, and/or air- conditioning (HVAC) system.
Unlike constant air volume (CAV) systems, which supply a constant airflow at a variable temperature, VAV systems vary the airflow at a constant temperature.

The advantages of VAV systems over constant-volume systems include more precise temperature control, reduced compressor wear, lower energy consumption, less fan noise.



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Components

Attenuators

(SILENCERS) Reduce noise produced by fan units and other equipment within Heating, Ventilating and Air Conditioning (HVAC) systems.

Generally mounted within the system’s ductwork, they ensure that a specific noise criteria is achieved within the internal or external areas served.

Components

Diffusers

Direct the air flow and reduce the velocity of the air. Air diffuser: a circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes, and arranged to promote mixing of primary air with secondary room air .

Damper –VCD

What is it?

A damper is a valve that stops or regulates the flow of air inside a duct, VAV box, air handler, or other air handling equipment. A damper may be used to cut off central air conditioning (heating or cooling) to an unused room, or to regulate it for room-by-room temperature and climate control.

How does it work?

Its operation can be manual or automatic. Manual dampers are turned by a handle on the outside of a duct. Automatic dampers are used to regulate airflow constantly and are operated by electric or pneumatic motors, in-turn controlled by a thermostat or building automation system. Automatic or motorised dampers may also be controlled by a solenoid, and the degree of air-flow calibrated, perhaps according to signals from the thermostat going to the actuator of the damper in order to modulate the flow of air-conditioned air to effect climate control.

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Air changes (ACH, ACPH)

What is it?

It is a measure of the air volume added to, or removed from a space (normally a room or house) divided by the volume of the space.

How to calculate it?

We’re changing CFM into Cubic Feet per Hour (CFH = CFM x 60). Then we calculate the volume of the room by multiplying the room height multiplied by the width multiplied by the length. Then we simply divide the CFH by the volume of the room.

$$ACH = \frac{CFM \times 60}{Height \times Width \times Length}$$

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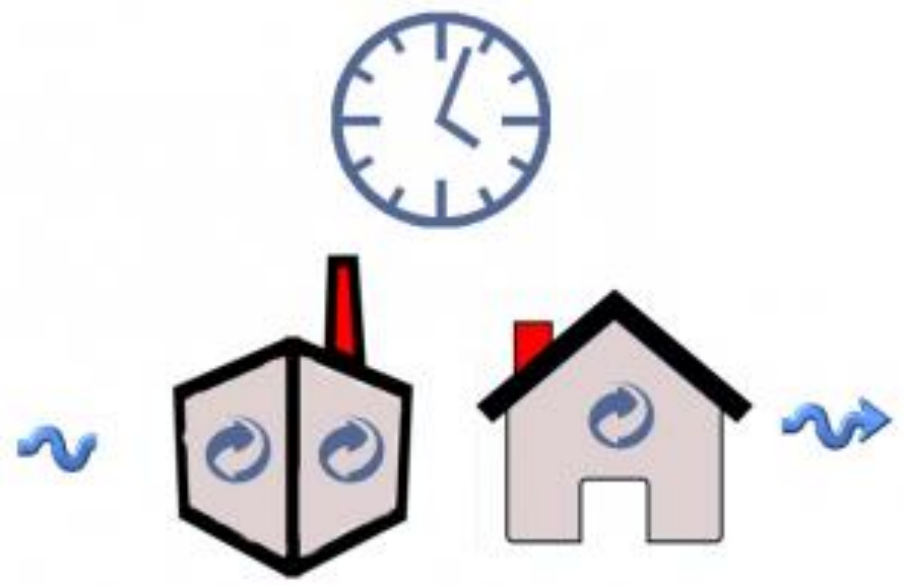
Air Changes Per Hour Table

Application	Air changes per hour
Banks	4 to 6
Cafes/Coffee Bars	10 to 12
Cellars	3 to 10
Changing Rooms	6 to 10
Cinemas/Theatres	6 to 10
Conference Rooms	8 to 10
Dance Halls	10 to 12
Dark rooms	10 to 15
Dental Surgeries	12 to 15
Entrance Halls	3 to 5
Factories/workshops	8 to 10
Garages	6 to 10
Gymnasiums	6 to 8
Hospital Wards	6 to 8
Kitchens – commercial	15 to 30
Laundries	10 to 15
Libraries	3 to 4
Offices	4 to 6
Public House Bars	6 to 10
Restaurants	10 to 15
Schoolrooms	4 to 6
Shops/supermarkets	8 to 10
Showers/Bathrooms	15 to 20
Stores/Warehouses	3 to 6
Swimming Baths	15 to 20
Toilets – public	6 to 8
Utility rooms	15 to 20



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Question Paper