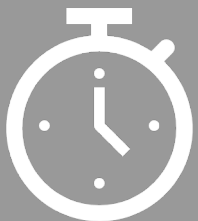


ZA 101.02 Basic Principles of Ventilation



20 minutes

Estimated duration to
complete this
Learning Segment



Zehnder Academy Learning Path

This segment is part of the training for:

Zehnder America Certified
Comfosystems 
SPECIFIER

Zehnder America Certified
Comfosystems 
INSTALLER

Zehnder America Authorized
Comfosystems 
TECHNICIAN

Zehnder America Authorized
Comfosystems 
DEALER

Zehnder America Authorized
Comfosystems 
DISTRIBUTOR

Knowledge Level:
Introductory

Recommended prerequisites:

- Zehnder Academy 101.01 – IAQ Basics

LEARNING
OBJECTIVE(S)



1. Describe how dilution relates to ventilation
2. Recognize the dynamics of natural ventilation
3. Compare methods of mechanical ventilation

Learning Objective #1

Describe how dilution relates to ventilation

Breaking ventilation down to the basics

The word “ventilation” means different things to different people.
For some, ventilation is a poorly-defined term.

- Any visible vent?
- Heating?
- Air conditioning?
- Fresh air?

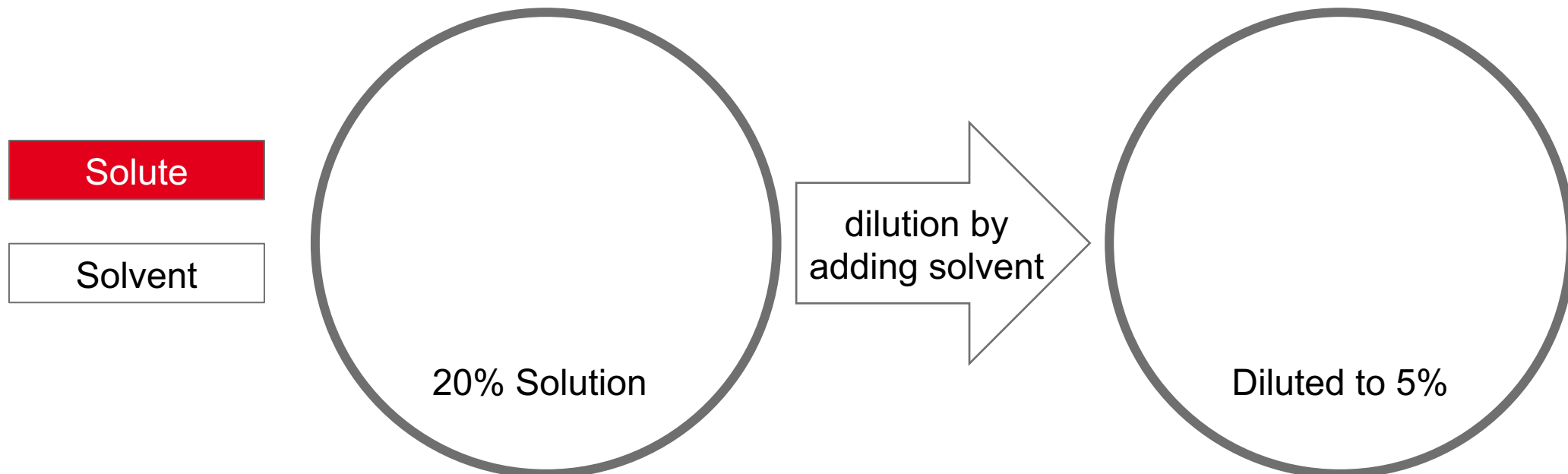
A heating/AC system is designed to improve thermal comfort.

True ventilation improves Indoor Air Quality and healthy living conditions.



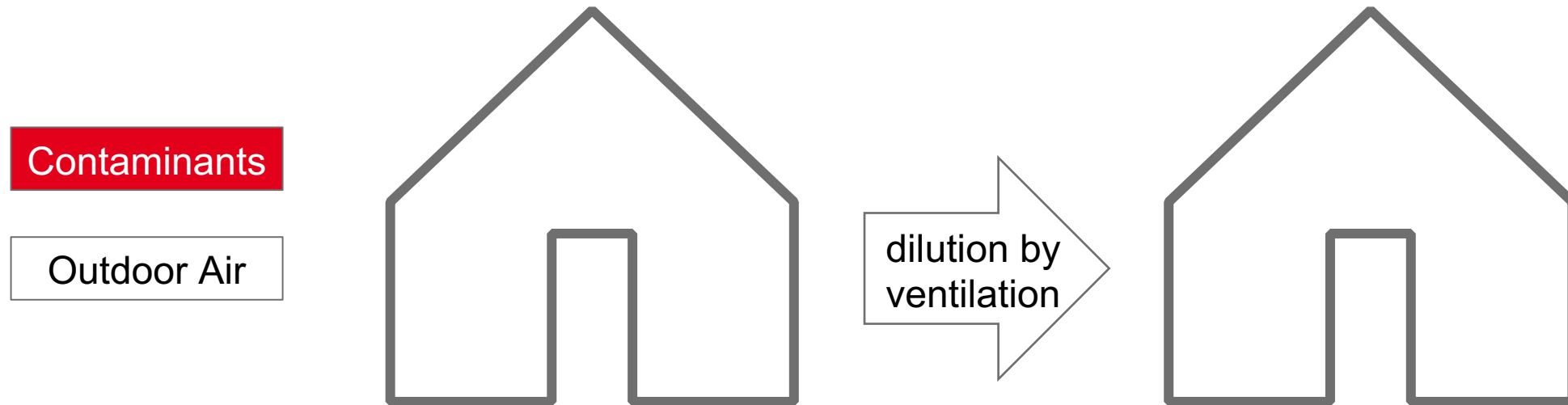
The principle of dilution

- Dilution: the action of making something weaker in force, content, or value
- Applied to fluids, dilution is the act of reducing the concentration of solute in a solution by adding solvent



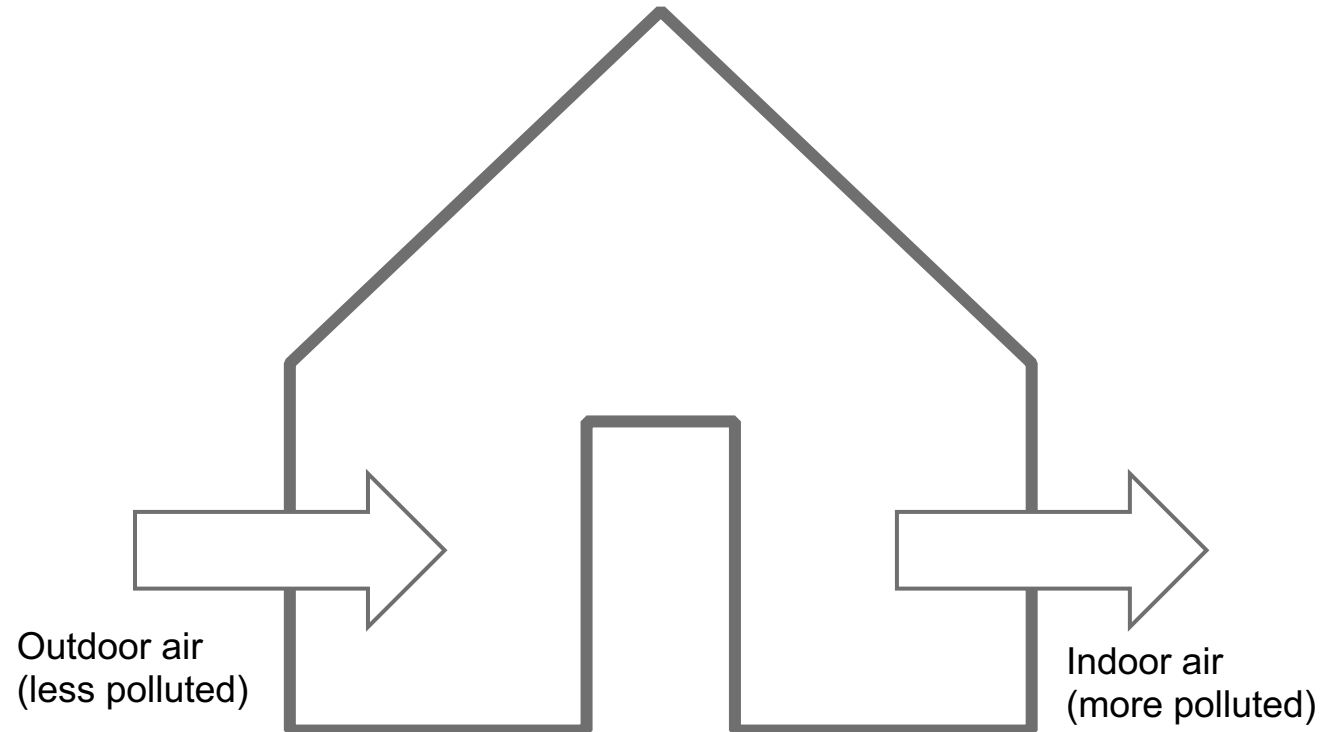
Dilution of indoor air pollution

- Air is a fluid
- The EPA says that indoor air is up to 5x more polluted than outdoor air
- That means that the concentration of indoor pollutants can be reduced by diluting the indoor air with outdoor air
- The movement of outdoor air into the building is called “ventilation”



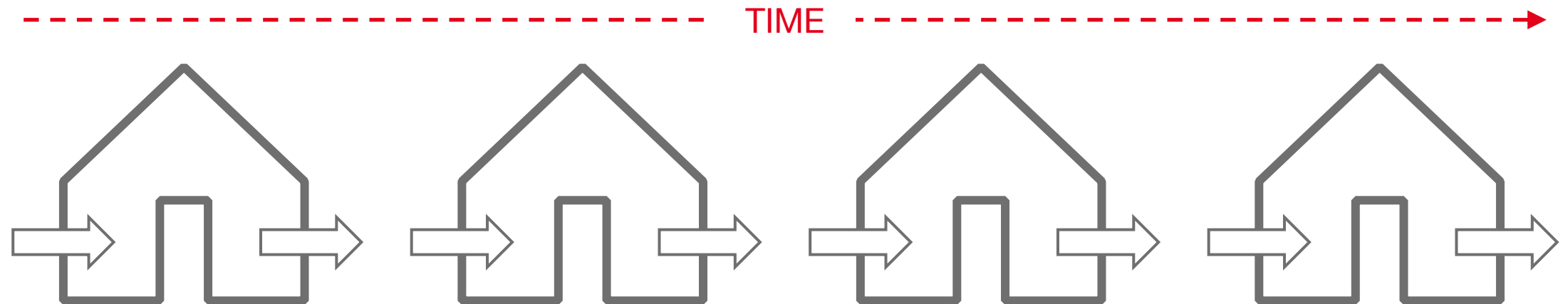
Ventilation and “air change”

- Diluting indoor air pollution isn't quite as simple as adding outdoor air. (Houses don't expand like balloons!)
- Air is actually exchanged during ventilation. Some amount of cleaner outdoor air enters the house while the same amount of more polluted indoor air exits the house.
- The method of air exchange may be natural, mechanical, or a combination of both.



Ventilation and air change


- Over the course of time, if more polluted indoor air continues to be replaced with cleaner outdoor air, the overall concentration of indoor pollutants will be reduced (diluted)
- Eventually, if the rate of ventilation is relatively constant and indoor conditions stay the same, the indoor air pollutants will reach a near-steady state
- A proper ventilation rate will approximately match the rate of generation of indoor contaminants, so the resulting “steady state” yields acceptable indoor air quality




Dilution, poetry and reality

In 101.01 “IAQ Basics” we pointed out that pollution source control and ventilation are both potential IAQ solutions.

Some people debate whether one or the other is the preferred solution, and they’ve gotten clever with their semantics...



Dilution is the solution to indoor pollution!



Dilution is **NOT** the solution to indoor pollution!

Dilution, poetry and reality

Anyone who has been in the presence of a dirty diaper knows that debate is silly.

Do both! Change the diaper and turn on the fan!

Homes should be built and maintained with non-polluting products whenever possible. However, since the occupants themselves are the source of many pollutants, ventilation is still necessary.





Knowledge Check

Learning Objective #1

Describe how dilution relates to ventilation

Which of the following best describes the goal of ventilation?

- A. Ventilation replaces indoor pollution with outdoor pollution.
- B. Ventilation concentrates pollutants inside the house.
- C. Ventilation dilutes pollutants inside the house.
- D. Ventilation distracts the occupants of the house.



Knowledge Check

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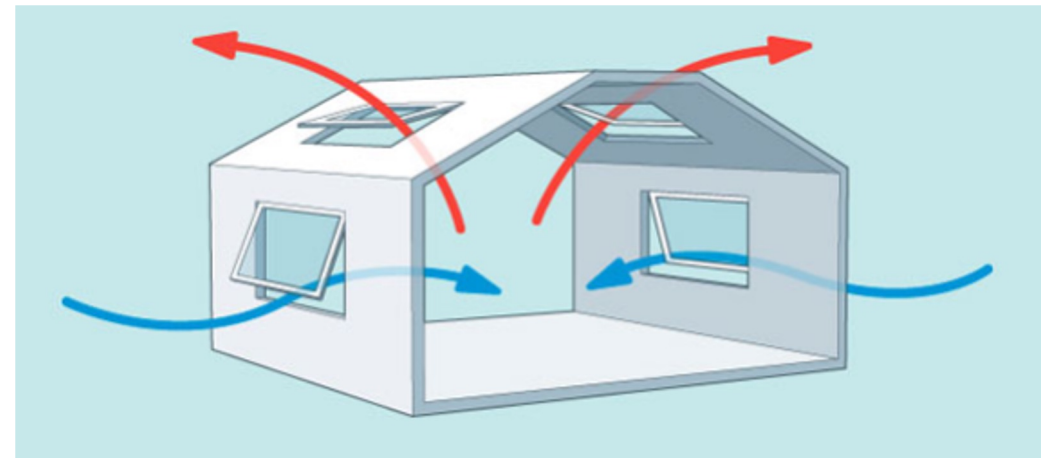
Learning Objective #2

Recognize the dynamics of natural ventilation

Natural Ventilation

Natural ventilation is when indoor air is exchanged with outdoor air without the use of any fans or blowers.

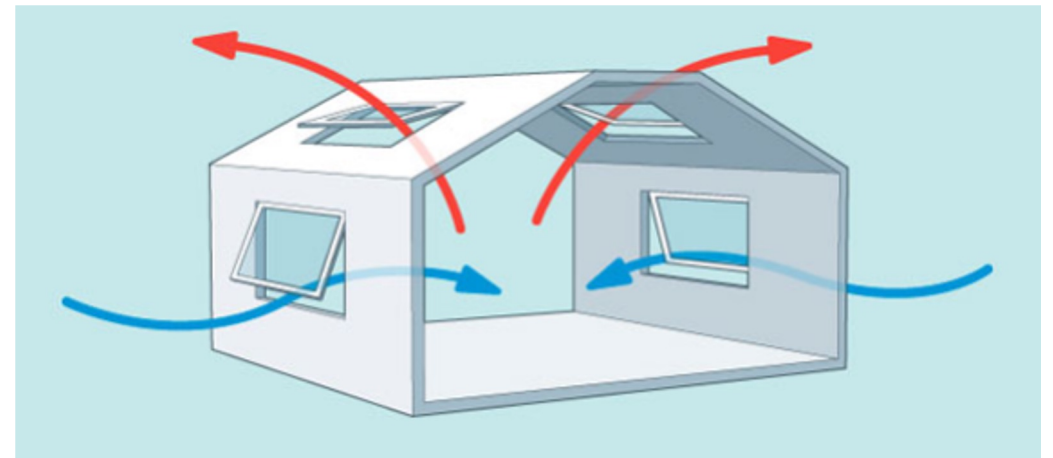
Whether controlled or uncontrolled, natural ventilation is driven by naturally occurring pressure differences between the outside and inside of the building.



Natural Ventilation

These pressure differences that drive natural ventilation are typically due to one of two factors:

- Wind pressure outside the building
- Stack effect inside the building

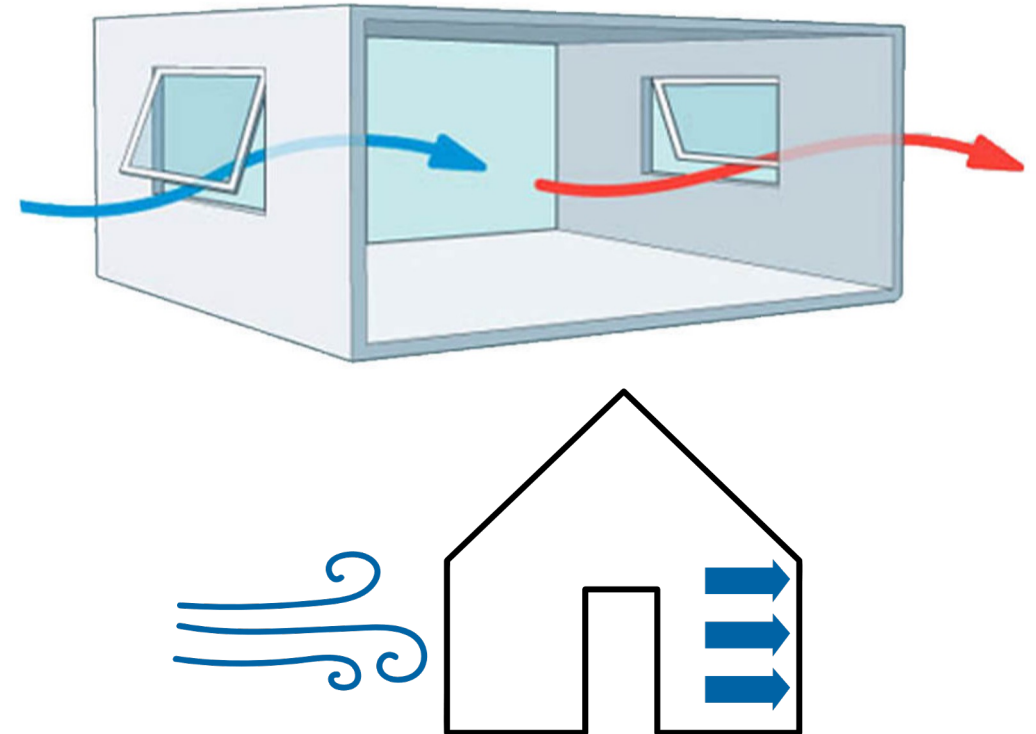


Wind Pressure

When there's a breeze outside, pressure typically builds up on one side of the building and forces air through openings into the building.

As pressure builds up inside the building, indoor air escapes through openings in the other side of the building.

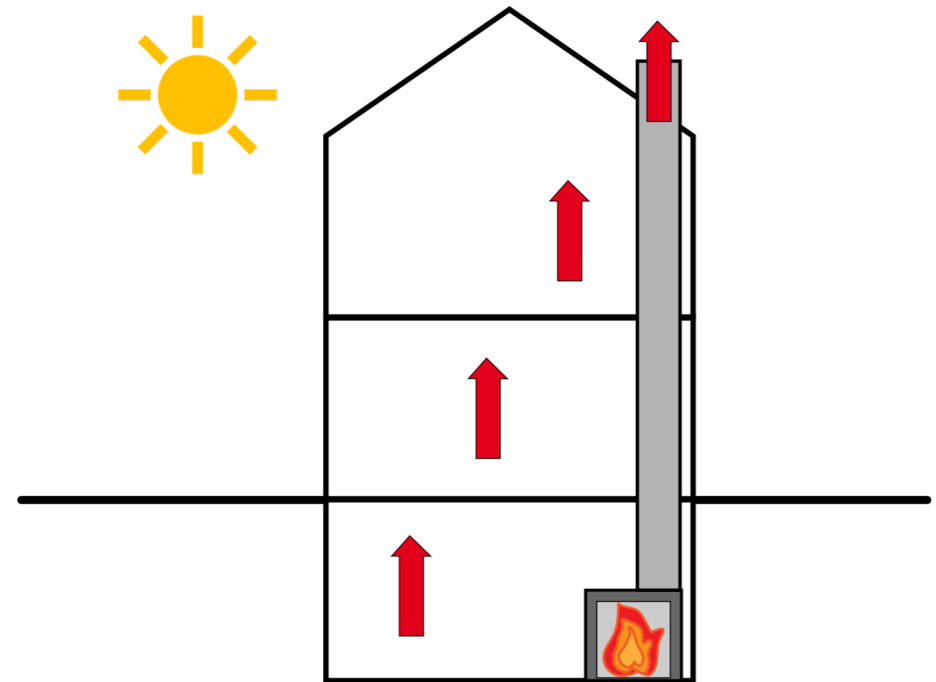
The result is some exchange of indoor and outdoor air (ventilation).



Stack Effect

Stack effect refers to changes in pressure inside the building due to temperature differences within the building.

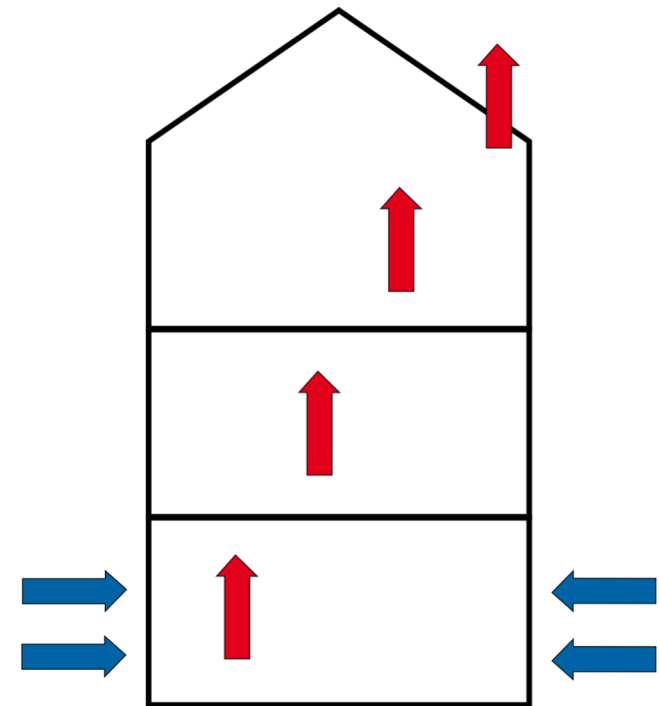
Warmer air is more buoyant than cooler air. Therefore, warmer air inside a building tends to rise towards the upper part of the building, just as hot air rises through a chimney stack (hence the phrase “stack effect”).



Stack Effect

Whether the indoor air is warmed intentionally by a heating system or unintentionally by sunshine or some other heat source like computer equipment, it will rise to the upper part of the building where it creates pressure and escapes through openings in the upper part of the building.

As this warm air rises and escapes, it creates a vacuum in the lower part of the building, depressurizing and causing outdoor air to be sucked in through openings in the lower part of the building. As stack effect continues, the result is some exchange of indoor and outdoor air (ventilation).





Knowledge Check

Learning Objective #2

Recognize the dynamics of
natural ventilation

How does stack effect cause air to move in and out of a building?

- A. When the occupants stack too many objects in the building it squeezes the air out.
- B. Warm air inside the building needs more oxygen and pulls the outdoor air inside.
- C. Warm air inside the building rises and pulls outdoor air in below it.
- D. Warm air expands and pushes out in every part of the building.



Knowledge Check

Learning Objective #2

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Natural Ventilation by Design

Windows, clerestories or vents can be designed to take advantage of wind and stack effect.

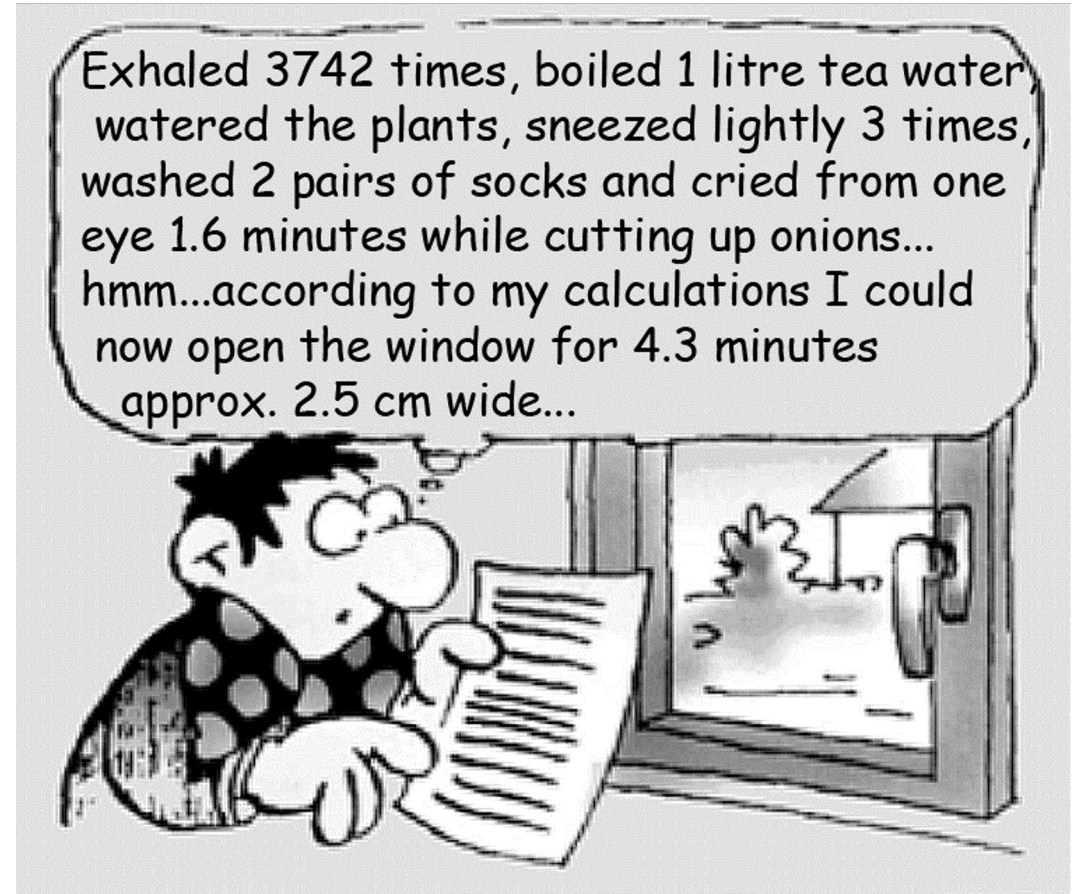
This was common in ancient architecture and still is in some moderate climates.



Natural Ventilation by Design

Natural window ventilation can be an economical way to ventilate a building, but only if the weather is favorable.

Even then it can be inconvenient to manage.



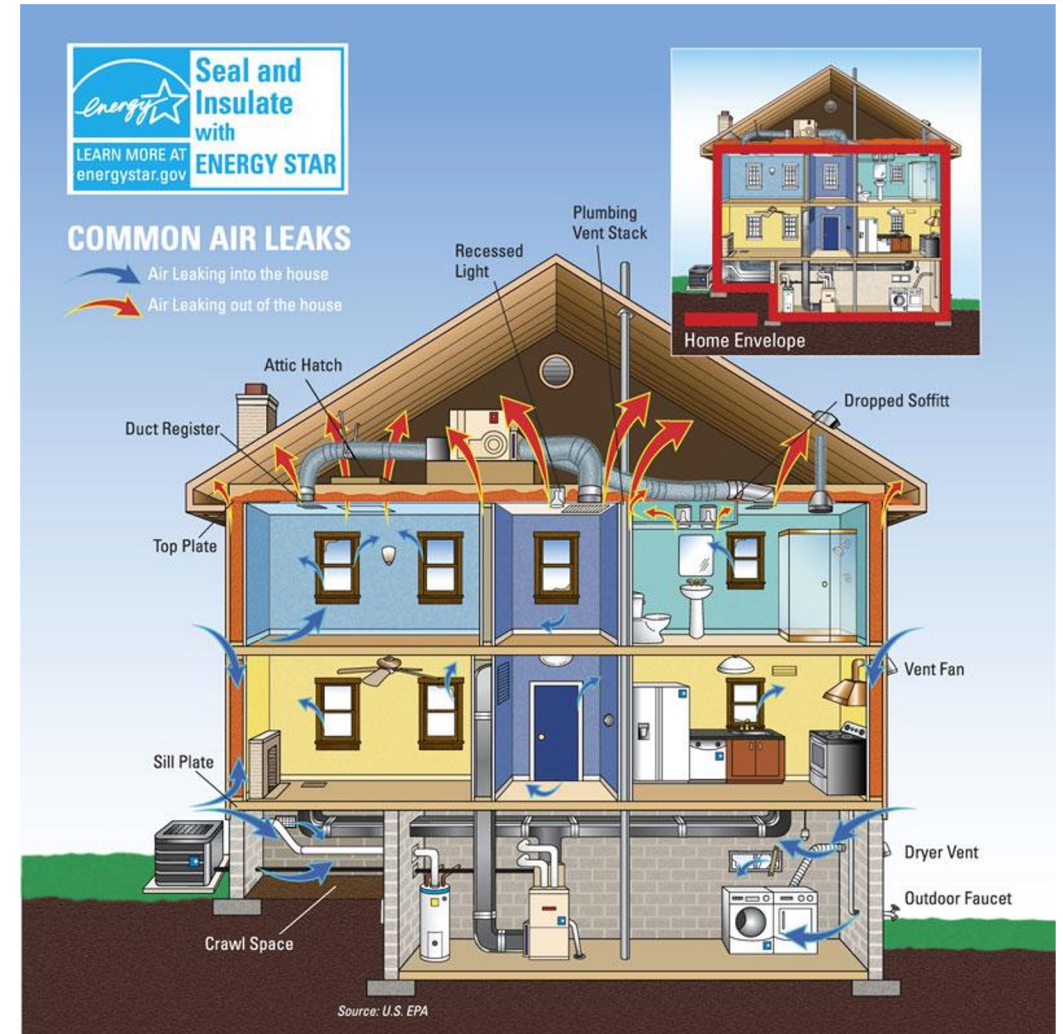
Infiltration and Exfiltration

Infiltration is when outdoor air enters the building through random leaks in the building.

This often occurs around windows, doors and pipes or at seams between building components.

Exfiltration is when air exits the building through leaks.

https://www.energystar.gov/sites/default/files/assets/images/S_I-house-LARGE-opt_0.jpg



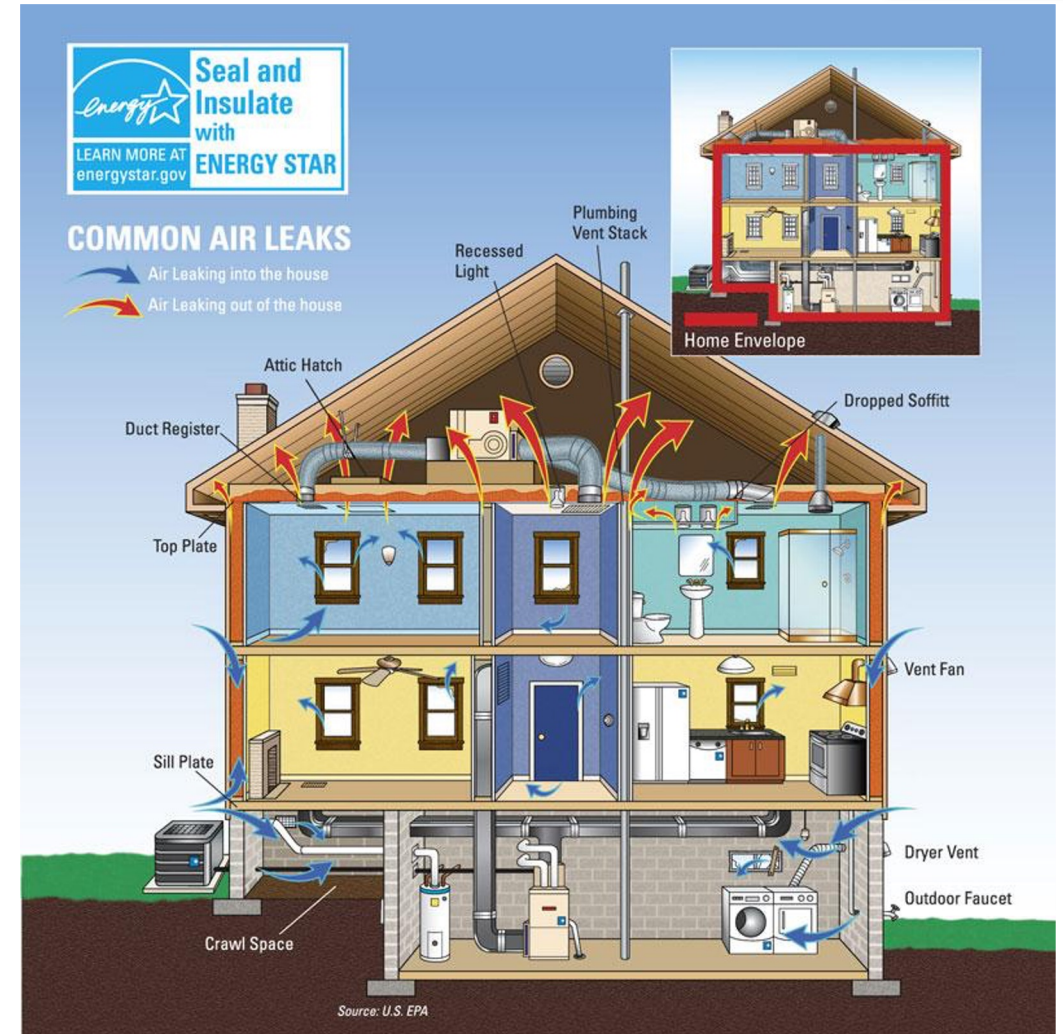
Infiltration and Exfiltration

Infiltration and exfiltration are driven by wind pressure and stack effect in almost every building.

This fact is acknowledged and accounted for in some ventilation codes.

At the same time, energy codes are also requiring increasingly airtight buildings that reduce this potential for natural air exchange.

https://www.energystar.gov/sites/default/files/assets/images/S_I-house-LARGE-opt_0.jpg



Quantifying Leakiness

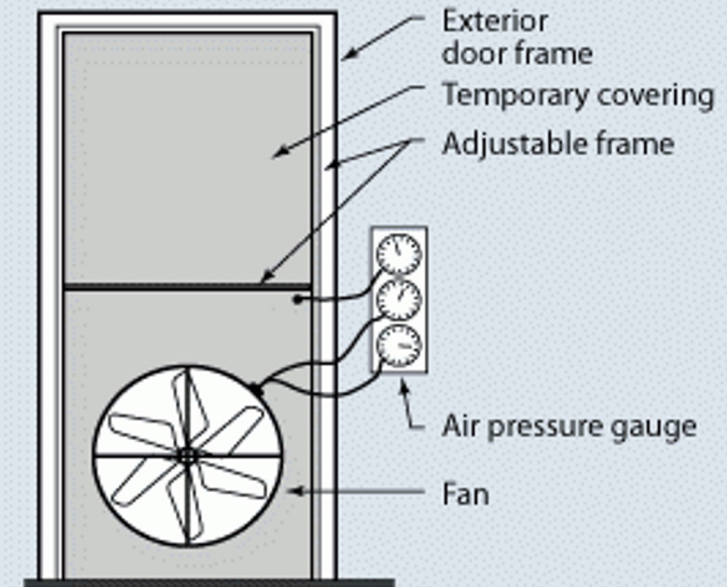
The leakiness of a building can be measured with a “blower door test”, which puts a building under artificial pressure and measures how much air enters or escapes through leaks.

The results of a blower door test can be used to quantify the potential for natural ventilation.

However, they are also used to determine whether the building has been constructed with enough airtightness to conserve energy.

Diagnostic Tools

Testing the airtightness of a home using a special fan called a blower door can help to ensure that air sealing work is effective. Often, energy efficiency incentive programs, such as the DOE/ EPA ENERGY STAR Program, require a blower door test (usually performed in less than an hour) to confirm the tightness of the house.



The Limitations of Natural Ventilation

Natural ventilation can be a contributing factor in Indoor Air Quality.

However, it, by itself, is not a reliable approach to maintaining air quality.

- Not comfortable year-round in most climates
- Difficult to control consistently
- Energy codes require increasing airtightness
- Uncontrolled air movement carries energy with it



Knowledge Check

Learning Objective #2

Recognize the dynamics of
natural ventilation

Which of the following is an example
of natural ventilation?

- A. A sea breeze flowing through a tiki hut.
- B. Warm air escaping out through an upper floor window.
- C. A winter storm blowing cold air through the cracks around a door.
- D. All of the above



Knowledge Check

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Learning Objective #3

Compare methods of mechanical ventilation

Mechanical Ventilation

Due to the limitations of natural ventilation, fans and blowers have been adapted in various ways to control air flow in and out of buildings.

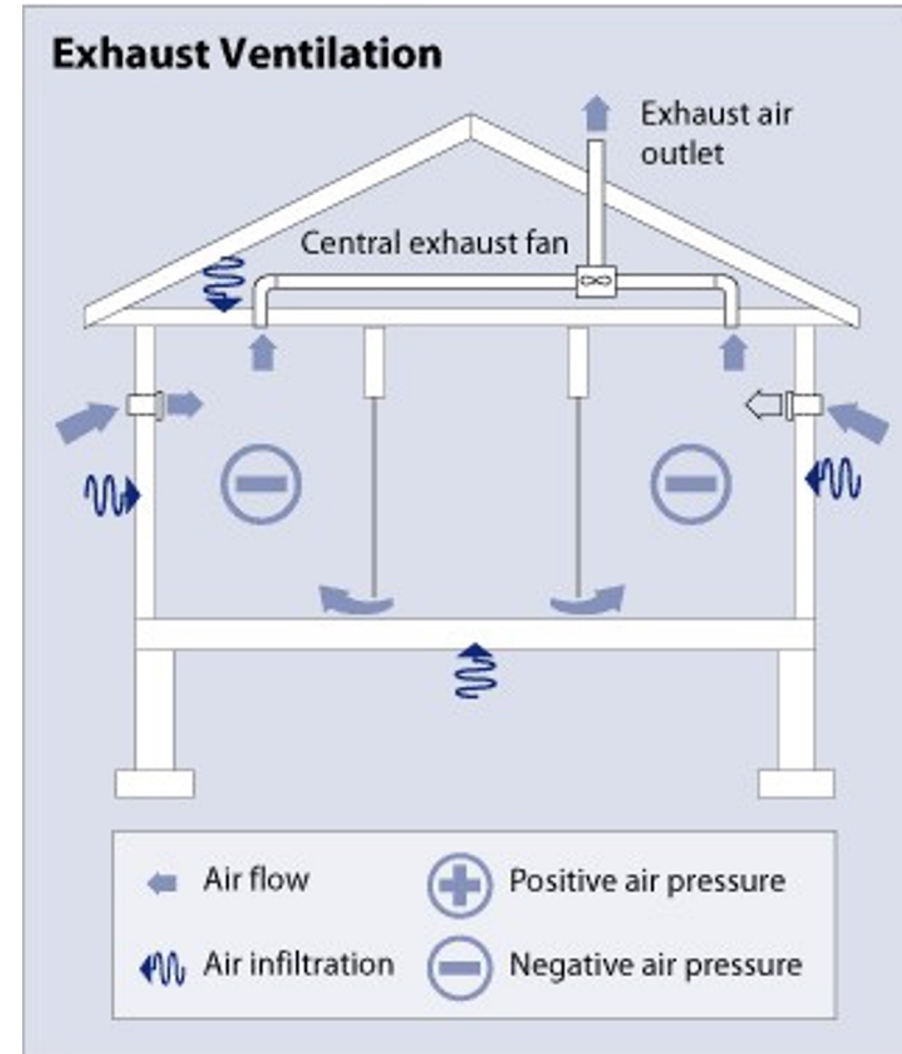
There are three basic types of mechanical ventilation...

- Exhaust-only
- Supply-only
- Balanced

Exhaust-only ventilation

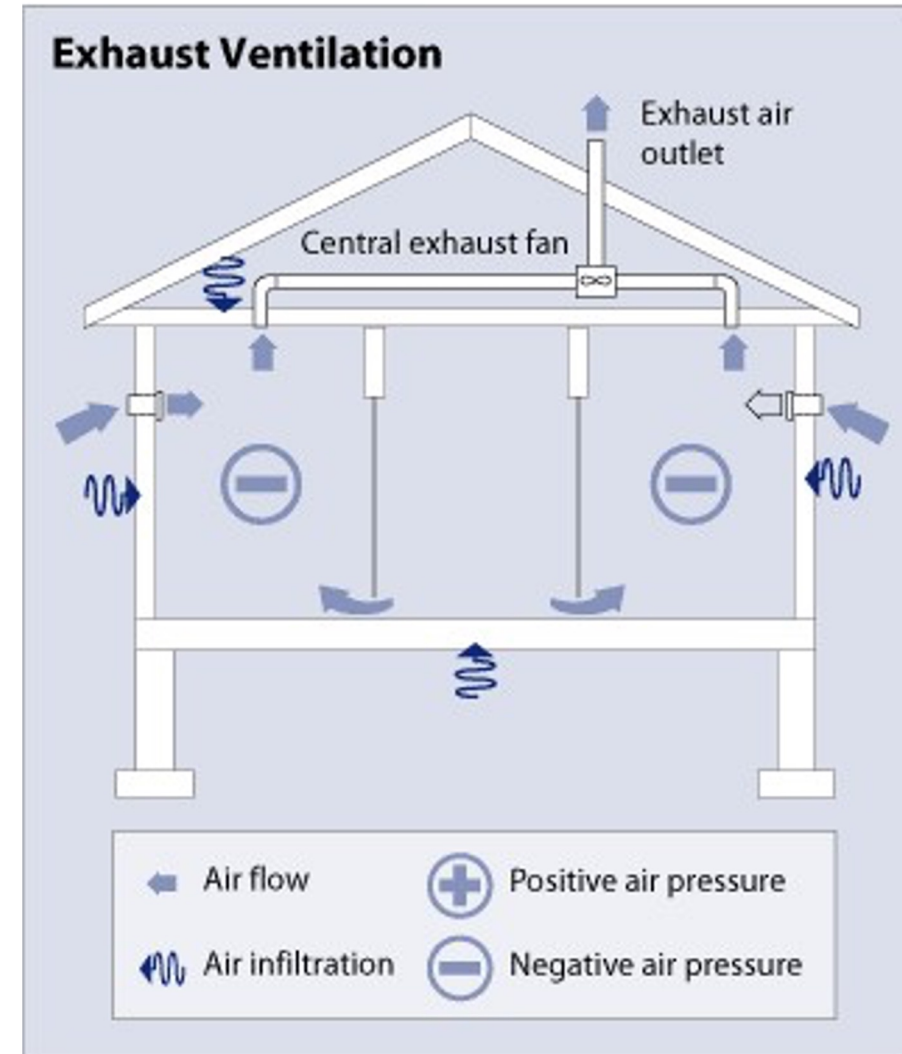
With exhaust-only ventilation, stale (polluted) indoor air is removed from the house with one or more exhaust fans. There may be a single fan located in an attic or multiple exhaust fans, typically located in the kitchen and bathrooms.

There is no fan to supply fresh outdoor air to the house. Instead, outdoor air enters through inlets or random leaks in the building envelope (infiltration).



Disadvantages

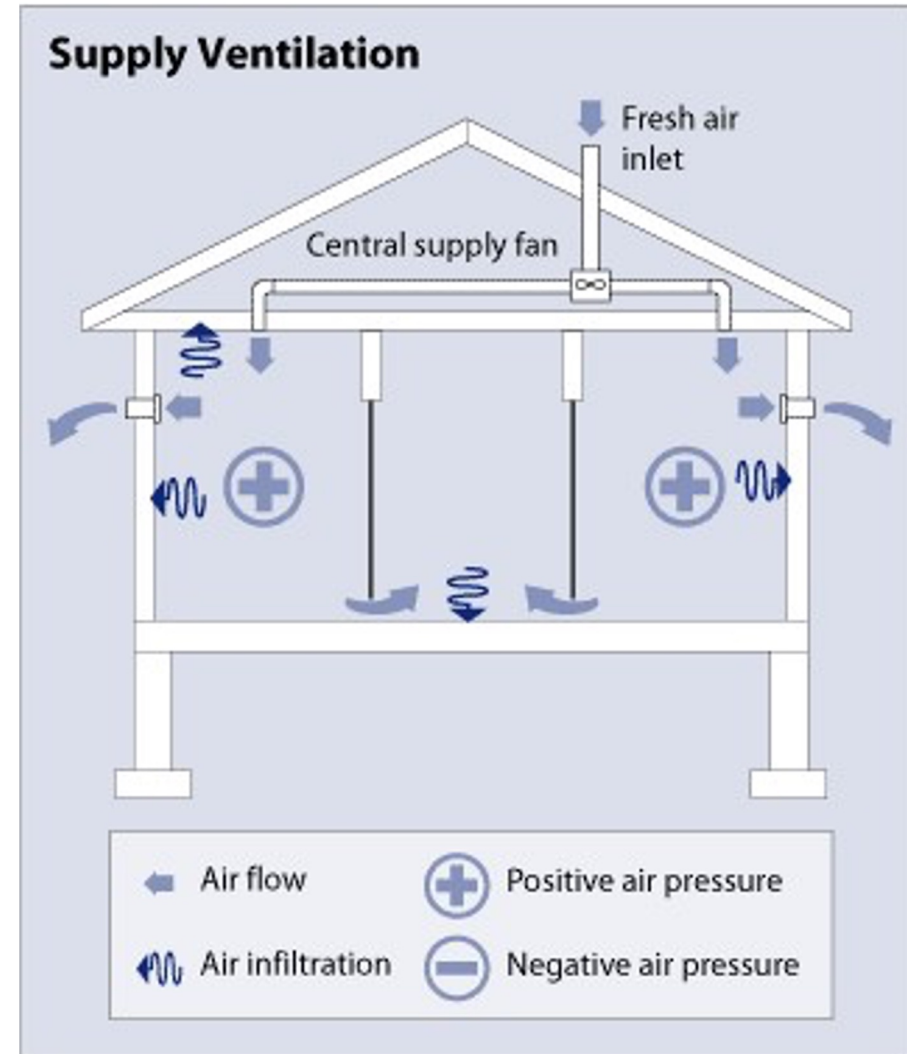
- Energy is lost through the exhaust air
- More energy must be spent to condition the infiltrated air
- Infiltrated air picks up pollutants as it passes through the building envelope
- Negative pressure in the house can draw radon into the living space
- Depressurization can occur in flue vents, bringing Carbon Monoxide back into the house
- In humid climates moist outdoor air can condense inside air-conditioned walls as it infiltrates the building envelope



Supply-only ventilation

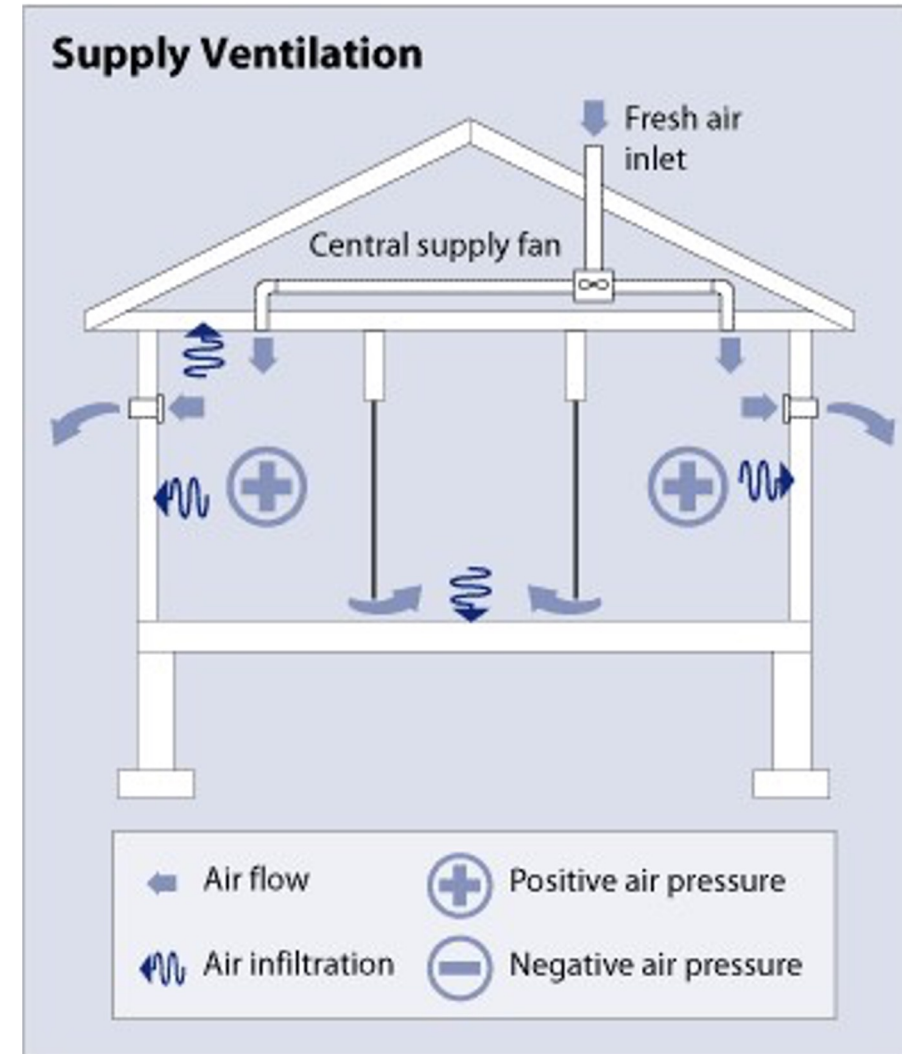
With supply-only ventilation, outdoor air is pulled into the home by one or more fans.

Instead of using exhaust fans, the house is pressurized by the supply fan and stale indoor air escapes through random leaks in the building envelope (exfiltration).



Disadvantages

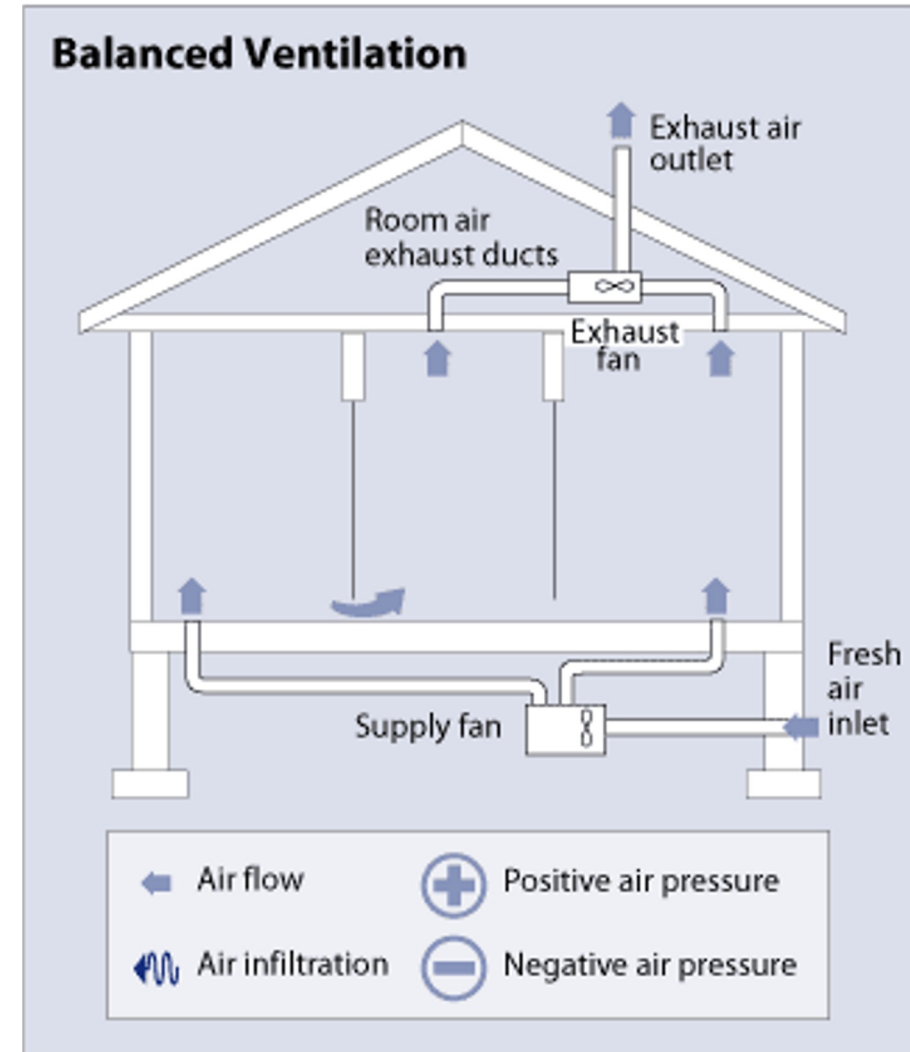
- The outdoor air is unconditioned and requires more energy to condition it
- Energy is also lost through exfiltration of the indoor air
- In cold climates during heating season, the exfiltrated air carries humidity through the building envelope and can condense inside cold exterior walls



Balanced ventilation

Balanced ventilation uses both a supply fan and an exhaust fan working together. This has several advantages...

- Ventilation is controlled at both the supply and exhaust points (not random)
- Neither infiltration nor exfiltration are driven by the ventilation system
- The outdoor air brings in less pollution and can be filtered
- Supply and exhaust fans can be combined into a single appliance
- Heat/energy recovery can be added for efficiency





Knowledge Check

Learning Objective #3

Compare methods of mechanical ventilation

What do exhaust-only and supply-only ventilation have in common?

- A. They both rely on air moving randomly through the building envelope.
- B. They both waste heating and air conditioning energy.
- C. They both use a fan or blower.
- D. All of the above.



Knowledge Check

Learning Objective #3

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ZA 101.02 Basic Principles of Ventilation

Thank you for taking this Learning Segment. We hope you found it informative.

Please explore Zehnder Academy's other course offerings and continue to grow your professional expertise.

