HVAC fundamentals

Natural, mechanical and hybrid ventilation compared

The different solutions for ventilating a building generally falls into the following categories:

- Natural
- Mechanical
- Hybrid

It is important to incorporate the chosen ventilation system early during the building design process, as to how the ventilation system is set up will influence the design of the building itself and failures in design can affect the lifetime performance and cost of the building.

Natural ventilation

Natural ventilation uses openings within the building fabric to facilitate the supply and extract of air, driven by the natural forces of temperature and wind.

- Wind-driven ventilation is caused by varying surface pressures acting on the exterior of a building, high pressure on the windward side and low pressure on the leeward side. This allows air to flow from areas of high pressure to areas of low pressure.
- Buoyancy-driven ventilation uses the fact that warm air is lighter than cold air, so a difference in pressure will be created. For example, hot air within a building rises creating an upward airflow through openings in the roof, which is replaced by cooler air at the lower levels. This is known as the stack effect.

The driving forces of Natural ventilation mean that the systems' effectiveness is determined by both the outdoor conditions (wind speed, temperature, and surrounding topography) and the building itself (orientation, windows/opening size and locations).

Natural ventilation can have the lowest capital (for simpler systems), annual energy running, and maintenance costs compared to the others ventilation systems. However, the effective design of natural ventilation within buildings is often extremely complex, sometimes costly and often not suitable for urban sites with high levels of noise and pollution.

Mechanical ventilation

Mechanical ventilation systems work by using fans to drive the flow of air into a building, by pressurising the building positively (supply ventilation system) or negatively (exhaust ventilation systems). Many systems incorporate both.

To control air quality and temperature, mechanical ventilation systems are often combined with:

- Heating elements: Electric Heater Batteries (EHB), Low-Pressure Hot Water (LPHW) coils
- Air conditioning: Heat pump, free cooling, dehumidifiers
- Heat exchangers or heat wheels
- Filters

Mechanical ventilation is the most adaptable of the ventilation systems:

- It can be set up to be centralised or decentralised to meet specific extract/supply, requirements work in all environments regardless of external conditions
- Can be fitted into almost all buildings, from being designed into the building from the start to functioning within existing structures
- Maintains indoor air quality (IAQ) and temperature consistently
- Is not adversely affected by external noise sources
- Has filters for outdoor contaminants
- Potential for heat recovery and cooling

Mechanical ventilation can have larger energy usages and capital costs, which includes maintenance and installation when compared to the other types of ventilation. But with the use of more efficient fans, more efficient air distributions and better ventilation controls, mechanical ventilation systems are now more and more energy efficient and able to provide improved air quality to any type of requirement.

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Hybrid ventilation

Hybrid ventilation systems provide a comfortable internal environment by using both natural and mechanical ventilation systems, switching between the different systems at different times of the day or season of the year. This is often referred to as 'mix-mode ventilation'.
Hybrid ventilation systems come in a variety of forms but consist of the following strategies:

- Contingency
- Complementary

Contingency strategies usually have natural ventilation and use mechanical systems in addition to help ventilate or cool the building. This can be the case when older buildings are being refurbished and required to meet more stringent regulations.

Complementary strategies are the most common type of Hybrid ventilation system, where natural and mechanical systems are both present and designed for integrated operation. These types of hybrid systems take advantage of the external ambient conditions as much as possible, by using mechanical ventilation systems to maintain IAQ and temperature when the external conditions are not favourable.

Hybrid ventilation takes the advantages of both mechanical and natural ventilation systems, resulting in decreased energy and capital cost when compared to mechanical systems. When compared to natural systems, it is more robust in meeting IAQ and heat/ cooling requirements in a larger array of conditions. This accounts for the growing interest in trying to implement hybrid ventilation systems into buildings, especially school buildings.

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