VENTILATION SYSTEM DESIGN AND THE RISK AREAS FOR SPREADING AIRBORNE CONTAMINANTS IN OFFICE BUILDINGS

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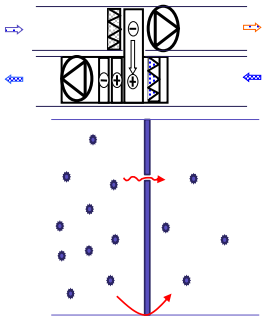
Airborne transmission from room to room

Even if buildings have well-functioning ventilation systems, which is the case in most Nordic countries, it does not mean that airborne infectious disease transmission from room to room could be avoided.



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Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

The **spread of airborne pollutants** depends on **air movement or airflow**.

Two prerequisites must be fulfilled for airflow from one room to another: **a pressure difference** and **a leakage path**.

Pressure differences in buildings can be created through **wind forces, temperature differences and mechanical ventilation.**

There must be **a careful design of a mechanical ventilation system** to accomplish directed airflows in a building, whereas **the pressure differences** created by **wind and temperature** are **considered disturbances**.

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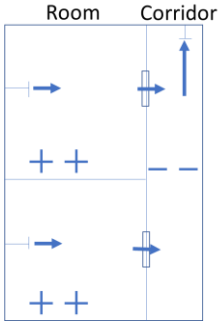
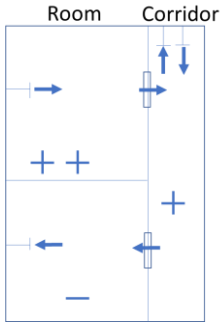
Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Depending on the balance between the supplied and exhausted airflows, **a mechanical ventilation system can create a pressure difference between the room and adjoining spaces**, both outside and between adjacent rooms.

The pressure difference depends on **the airtightness of the building envelope** and the **interior walls** and **airflow balance**.





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Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Most of the new office buildings in **Nordic countries** are equipped with balanced mechanical ventilation systems.

The most common solutions in the office buildings are variable-air-volume (VAV) systems.

The ventilation systems should be able to **precisely control the indoor climate** or otherwise the target values of indoor temperature or CO_2 concentration may not be fulfilled.

Photo: Lindab, Denmark

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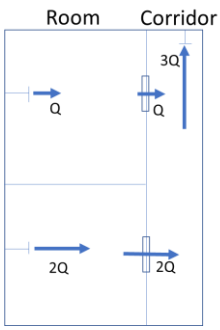
Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Typical Design of **Swedish** Office Buildings

Transferred air is often used in Swedish offices.

The air **is supplied to the office rooms** and **transferred into the adjoining corridor** where it is exhausted.

Special air terminal devices are used to accomplish this, allowing air to pass from the room to the corridor. These devices constitute a known opening, a controlled leakage path for the air.



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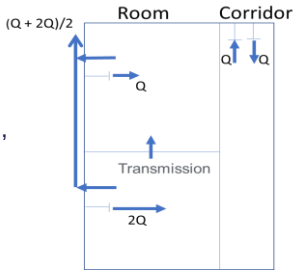
Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Typical Design of **Danish** Office Buildings

Supply and exhaust air is installed in every room.

Equal volumes of air are brought into and exhausted out of **the building**. However, in **a room**, the supplied air volume **is not equal** to the exhausted air volume when the supply air volume varies in a variable air volume system.

Thus, a common exhaust is used, and the **exhaust airflow rate from each room is an average airflow** rate from several given rooms.



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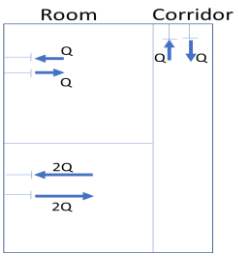
Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Typical Design of **Norwegian** Office Buildings

In Norway, the most common ventilation system in new office buildings is the balanced-room ventilation system.

In such systems, **the supply and exhaust sections usually depend on each other**; thus, the variation is often equal for the supply and exhaust air. This dependence **cannot cause over or under pressure in the rooms.**



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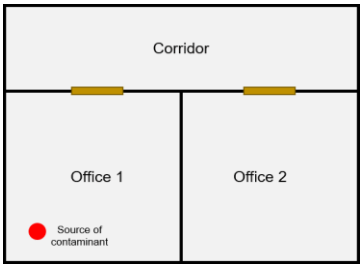
Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Simulation study

All three zones have the same volume (27 m^3), but different supply ventilation rates.

The zones were modelled assuming complete mixing of air.

Bi-directional airflow between offices and the corridor was modelled using a door model with a **leakage area of 0.02 m^2** when **the door is closed**.



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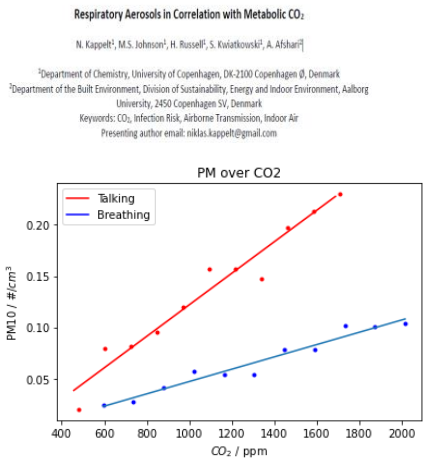
Source of contaminant

Typical increase of PM10 in relation to CO_2, comparing **breathing and talking**, is shown in the figure , **strong correlation.**


Respiratory Aerosols in Correlation with Metabolic CO_2

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Keywords: CO_2, Infection Risk, Airborne Transmission, Indoor Air
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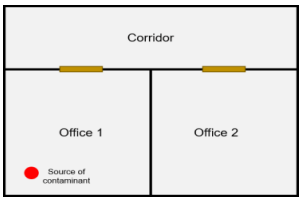
Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Simulation study

Table shows supply and exhaust ventilation rates for each ventilation system, together with the airflow passing through the doors.



	Supply ventilation rate [l/s]			Exhaust ventilation rate [l/s]			Airflow through doors [l/s]	
	Office 1	Office 2	Corridor	Office 1	Office 2	Corridor	Door 1	Door 2
Denmark	60	30	17	45	45	17	15	-15
Sweden	60	30	17	0	0	107	60	30
Norway	60	30	17	60	30	17	0	0

Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Tabel Pressure differences **[Pa]** across doors

	Doors open		Doors closed	
	Office 1 – Corridor	Office 2- Corridor	Office 1– Corridor	Office 2- Corridor
Denmark	0.001	-0.001	0.4	-0.4
Sweden	0.003	0.001	10	3.5
Norway	0	0	0	0

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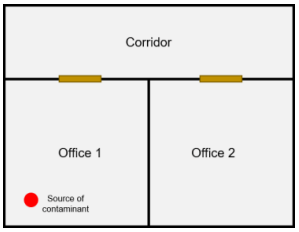
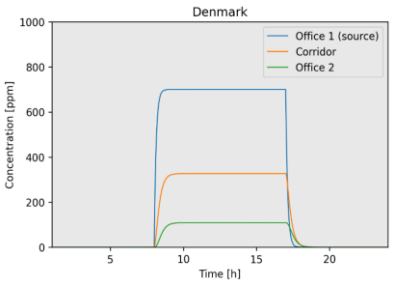
Denmark





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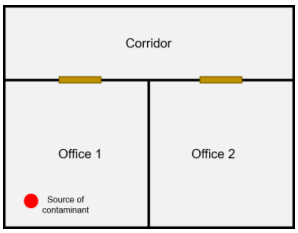
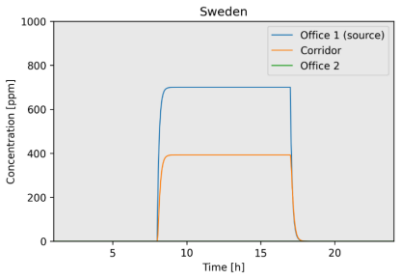
Sweden





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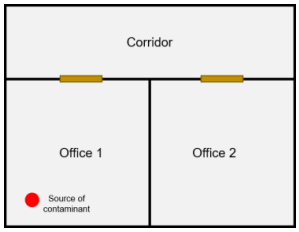
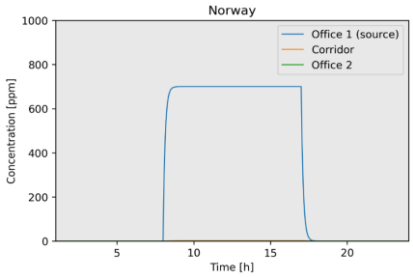
Norway





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Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Conclusions

The existing ventilation systems of **Swedish office rooms** can contribute to spreading airborne contaminants from office rooms to corridors but not to adjacent rooms.

Airflows should be supplied and exhausted from each room and from each corridor to avoid spreading airborne contamination to corridors.

Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Conclusions

The existing ventilation systems of **Danish office rooms** can contribute to spreading airborne contaminants from room to room when the room demands are different.

The extracted airflows must be equal to the supplied airflows of each room to achieve the correct pressurization.

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Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

Conclusions

The existing ventilation systems of **Norwegian office rooms** do not spread airborne contaminants from room to room or from room to corridor, even if the room demands are different.

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Ventilation system design and the risk areas for spreading airborne contaminants in office buildings

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Ventilation System Design and the Coronavirus (COVID-19)

Provisionally accepted The final, formatted version of the article will be published soon. Notify me

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Thank you

for your attention