

Carbon dioxide, airborne virus stability and indoor air quality: what the evidence means for buildings

Executive summary: what we know, what remains uncertain, and what it means for Maxairea

Carbon dioxide is usually treated as a signal of how well an occupied room is ventilated. New laboratory research suggests it may have a second role: the carbon dioxide level around a respiratory particle may influence how quickly severe acute respiratory syndrome coronavirus 2 loses infectivity after exhalation.

This matters, but it must be interpreted carefully. In controlled experiments, higher surrounding carbon dioxide has helped the virus remain infectious for longer by changing the chemistry of the respiratory droplet. Real buildings are more complex: particle size, relative humidity and other gases in indoor air can change the same chemistry and may weaken, strengthen or reverse the effect.

Bottom line: lower carbon dioxide may influence how quickly the virus loses infectivity, but this has not been proven as a stand-alone infection-control measure in occupied buildings.

1. What laboratory studies show

Respiratory droplets leave the body from an environment with very high carbon dioxide. After exhalation into air with a lower carbon dioxide level, carbon dioxide can leave the droplet and shift its chemical balance. In several controlled studies, this made the droplet more alkaline and the virus lost infectivity faster. Raising the surrounding carbon dioxide reduced that chemical shift and increased the time the virus remained infectious. Different virus variants responded differently.

2. Why real buildings may behave differently

Indoor air contains acidic and basic trace gases that can enter respiratory particles. Particle size strongly affects how quickly this happens. Modelling indicates that small particles, which can stay airborne for long periods, may become acidic within minutes or even seconds under representative indoor conditions. Larger droplets can follow a different chemical path. Relative humidity adds another layer. It changes how quickly particles evaporate, how concentrated their salts become and whether those salts crystallise. These changes can alter both the timing and the rate of viral decay. Carbon dioxide is therefore one important chemical driver, not the whole story.

3. What this means for indoor air quality management

Ventilation and particle removal remain the core controls for airborne exposure. Outdoor air dilutes and removes occupant-generated respiratory particles. Suitable particle filtration and other air-cleaning measures can provide additional removal. Carbon dioxide remains useful for ventilation control, but its reading must be interpreted differently when the carbon dioxide concentration of the incoming fresh air is deliberately reduced. In that case, a lower indoor carbon dioxide level reflects both the fresh-air flow rate and the lower carbon dioxide concentration of the supply air. It should therefore not be used on its own as proof of a high ventilation rate or as an infection-safety threshold. Infection risk still depends on whether an infectious person is present, how much virus is released, airflow, exposure time and how effectively airborne particles are removed.

4. What this means for Maxairea

Value that can be applied today. There is no recirculation through the Maxairea carbon dioxide removal step. Maxairea treats only the incoming fresh outdoor air, lowering its carbon dioxide concentration before that air enters the building. Because the incoming air starts with less carbon dioxide, each cubic metre of fresh air has greater capacity to dilute the carbon dioxide generated by occupants. This allows an indoor target below 900 parts per million to be maintained with less incoming fresh air than would be needed with untreated outdoor air. The lower fresh-air demand can reduce the energy used to heat, cool and move outdoor air. However, the system

never reduces the incoming fresh-air supply below 24 cubic metres per hour per person. This minimum fresh-air supply remains an independent safeguard, alongside particle control and management of other contaminants.

Research opportunity. Laboratory evidence creates a separate testable question: at the same fresh-air flow rate, does lowering carbon dioxide in the incoming fresh air reduce the room carbon dioxide level enough to make virus-containing respiratory particles lose infectivity faster? The mechanism is scientifically plausible, but the effect has not yet been demonstrated in real buildings. It should therefore be studied, not marketed as a proven health benefit.

5. Recommended next step: test the effect independently

A useful validation study should separate carbon dioxide removal from ventilation and particle removal. First, keep the fresh-air flow rate and particle removal constant, then compare untreated incoming outdoor air with incoming air whose carbon dioxide concentration has been lowered by Maxairea. Measure the carbon dioxide concentration in the supply air and in the room, together with how quickly virus-containing respiratory particles lose infectivity across different particle sizes, relative humidity levels and trace-gas conditions. A second test should keep the indoor carbon dioxide target below 900 parts per million and compare the fresh-air flow required with and without carbon dioxide removal, while always maintaining at least 24 cubic metres of fresh air per hour per person.

A second phase should repeat the comparison in a representative building. This would answer the question that matters for Maxairea: does lowering the carbon dioxide content of incoming fresh air create a measurable airborne-virus benefit beyond its proven value of improving carbon dioxide dilution efficiency and reducing ventilation-related energy demand?

The message to carry forward: Maxairea lowers the carbon dioxide content of incoming fresh air before it enters the building. This makes each cubic metre of fresh air more effective at diluting occupant-generated carbon dioxide, allowing an indoor target below 900 parts per million to be maintained with less incoming fresh air than would be required with untreated outdoor air. The fresh-air supply never falls below 24 cubic metres per hour per person. The possible effect on airborne virus stability is a separate research opportunity and should be validated under representative building conditions before any infection-risk claim is made.

Evidence base: supporting studies by Haddrell and colleagues (2023 and 2024), Klein and colleagues (2022), and Webner and colleagues (2025), together with TNO desk research by indoor air quality expert Piet Jacobs.