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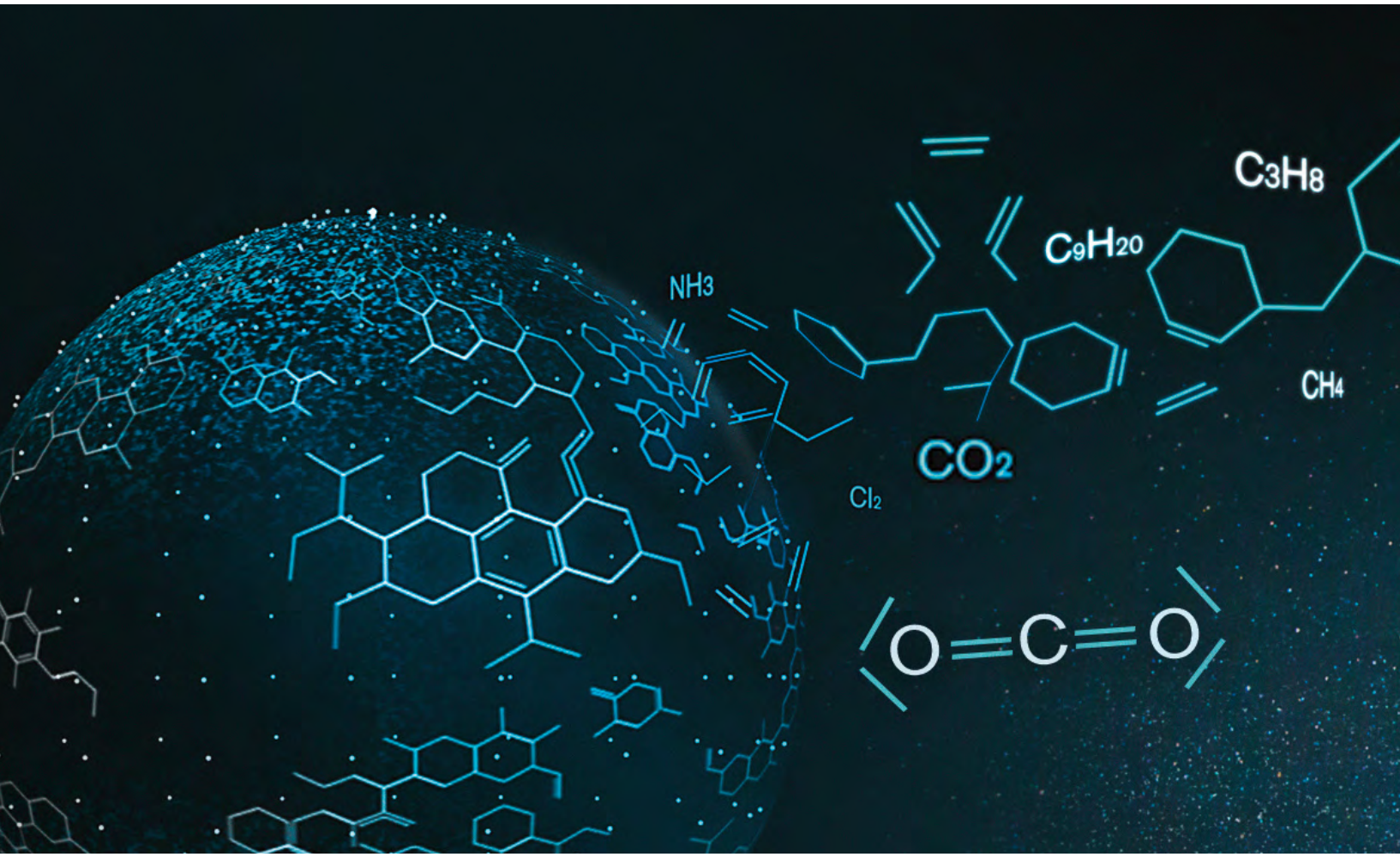

The role of CO_2 in monitoring the safety of indoor air

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Indoor air quality has a significant impact on our health and well being. This is especially true in times of a pandemic. An important indicator of air quality is carbon dioxide (CO_2).

Adults tend to stay indoors for around 80 to 90 percent of the day – at home or work, in schools and universities, as well as in cars and on public transportation[1]. Indoor air that is as unpolluted as possible is therefore critical to health and well-being.

Adults spend up to **90%** of the day indoors.

The mere presence of humans causes contamination of indoor air. People breathe in oxygen, then exhale carbon dioxide and often organic substances such as acetone, alcohol and odors into the air. These substances can cause fatigue, mucosal irritation, and other symptoms.

GUIDELINES FOR CO_2 CONCENTRATION

To assess the quality of indoor air, there are guideline values for individual pollutants. For carbon dioxide, there are directional, orientation and target values for the maximum concentration that should exist indoors. CO_2 content in the air is expressed in parts per million (ppm).

The National Institute for Occupational Safety and Health (NIOSH) recommends a maximum CO_2 concentration of 1,000 ppm under normal conditions as an indication of a hygienically sufficient air change.

Although too much carbon dioxide can have an impact on health, humans do not directly or consciously perceive too high of a concentration in the breathing air. Signs of high CO_2-concentration can be nausea, dizziness, severe headaches, and increased breathing rates. It can also result in a higher transmission of diseases.

CO_2 IS AN INDICATOR OF INFECTION RISKS

Indoor air may also contain another potential source of danger: infectious aerosols exhaled by humans.

Aerosols are suspensions of fine solid particles or liquid droplets in air or another gas. Aerosol particles can vary in size from a diameter of about 1 nanometer (nm) up to several 100 microns (microns). While larger particles quickly sink to the ground, particles smaller than 10 microns can remain in the air for hours to days.

Since the entire range of particles in the air, including aerosols, is difficult to accurately detect, indoor air quality is often estimated using the more easily detected CO_2 levels. Therefore, higher levels of carbon dioxide serve as an indicator of poor air quality.

In many metabolic processes, such as energy production, carbon dioxide is produced in the human body from oxygen. CO_2 is transported through the veins into the lungs, enters the airways, and then is exhaled. Our exhaled breath is therefore full of CO_2 molecules. In large cities, of one million suspended particles in the air, approximately 350 parts are CO_2. In the exhaled breath, the proportion is about 100 times higher. That explains why CO_2 levels can increase rapidly when people gather in a poorly ventilated room.

Exhaled aerosols can remain in the air over extended periods of time. Donald Milton, Associate Professor of Occupational and Environmental Health at the Harvard School of Public Health, has been working for decades to use CO_2 concentration levels of indoor air to assess the risk of transmitting certain diseases. He found that the higher the proportion of CO_2 particles, the higher the amount of air that has been re-breathed several times. Re-breathing also increases the risk of inhaling aerosols that another person has previously exhaled in the same room.

Exhaled aerosols can remain in the air over **extended periods of time.**

Together with Stephen Rudnick, Milton was able to demonstrate that the risk of being infected with the flu more than doubled at CO_2 concentration levels of 2,000 ppm, and tripled at 3,000 ppm (compared to 1,000 ppm CO_2)[2].

CO_2 concentration is therefore an indirect measurement of possible exposure to viral aerosols. In the meantime, various studies have confirmed that CO_2 is an indicator of the quality of indoor air in rooms as a whole.

CO_2 DETECTOR HELPS DETERMINE WHEN TO INCREASE AIR FLOW

It is generally recommended that when a CO_2 concentration of 1,000 ppm is reached, the room should be ventilated. At a concentration of 2,000 ppm, it becomes essential to properly ventilate the room to ensure an appropriately measured air quality. However, as already noted, humans are not able to detect

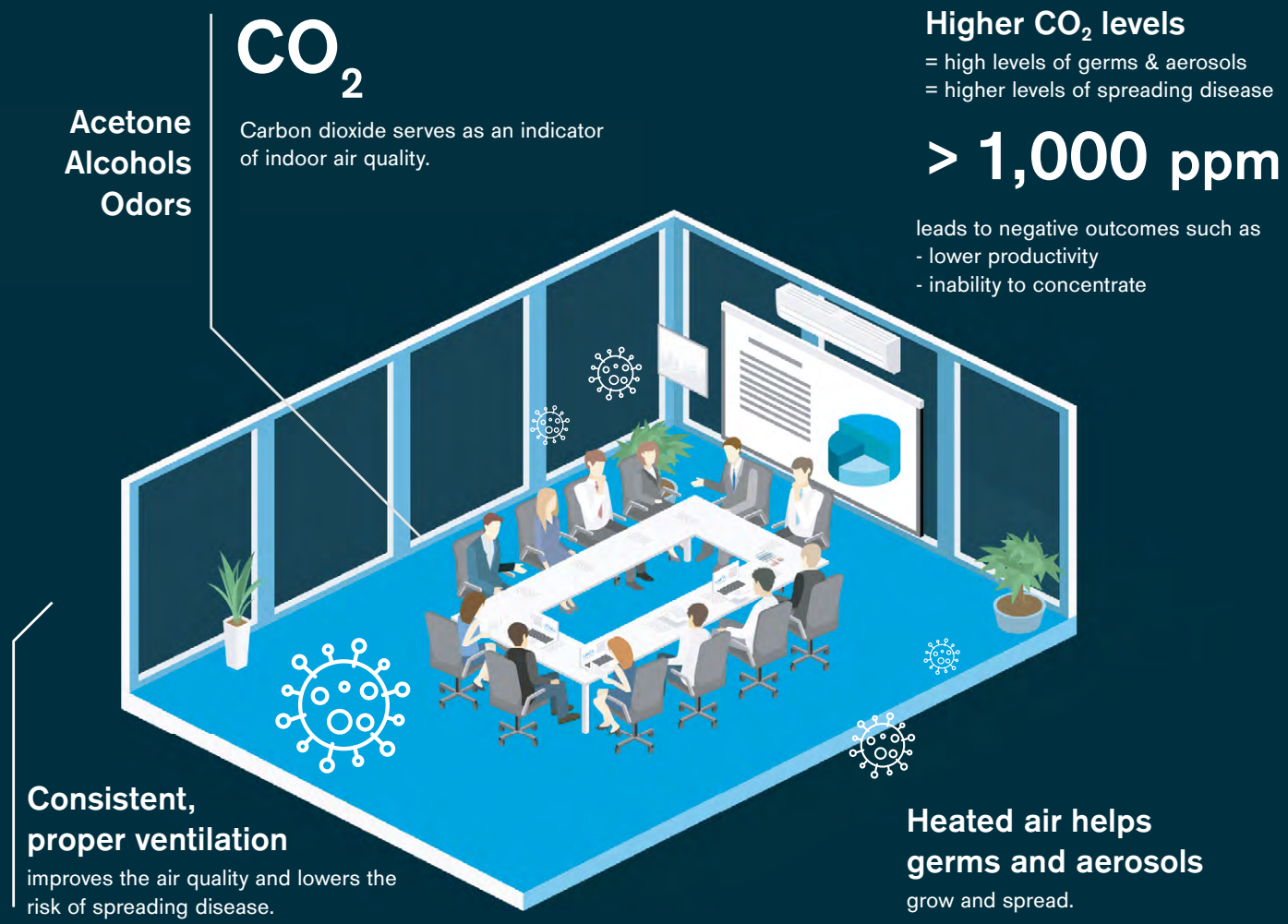
high levels of carbon dioxide. In theory, one could measure the aerosols in the air and sound the alarm if there were too many. The drawback is that aerosol measuring instruments are complicated to operate and maintain, and are expensive.

CO_2 monitoring helps **reduce the risk of infectious diseases.**

CO_2 measuring instruments, on the other hand, are easier to use and are usually much less expensive. The latest gas detection technologies enable the user to read measurements and evaluate the data through data logging using mobile and stationary devices. The results and visual diagrams can be downloaded quickly and easily. With the help of these monitoring devices, high or harmful concentrations of CO_2 and other hazards in the air can be quickly identified. This enables occupants in the building or affected rooms to protect themselves against inadequate indoor air quality.

CO_2 monitoring helps reduce the risk of infectious diseases. To summarize, CO_2 detectors can be very helpful because they indicate when the level of aerosols in a room are higher – thus increasing the risk of infection. It is important to note that a CO_2 concentration of less than 1,000 ppm does not fundamentally lower the risk against infection with SARS or COVID-19. However, CO_2 concentrations significantly or permanently greater than 1,000 ppm, combined with insufficient ventilation, have the potential to increase the risk of infection.

If a high occupant density in a building or room cannot be avoided, using CO_2 detectors is recommended, especially where only windows can be opened, versus having a ventilation system. CO_2 detectors are thus a good indicator of when it is necessary to install a ventilation system. Depending on the application, there are a wide range of CO_2 detection solutions.



DRÄGER SOLUTIONS FOR MEASURING CO_2 INDOORS

Dräger offers several simple and reliable solutions for monitoring CO_2 levels in different applications. The Dräger Pac® 8000 CO_2 is a single-gas detector that is technologically advanced, yet very easy to use.

DrägerSensor® technology can measure indoor CO_2 volume from 0% to a maximum of 5%. This range is critical, because OSHA (Occupational Safety & Health Administration) has determined that the IDLH level (Immediately Dangerous to Life & Health) is 4% by volume, or 40,000 ppm. Accuracy is an essential quality of any sensor, and at 0.03% deviation this sensor is one of the most accurate in the industry.

A multi-gas alternative is the Dräger X-am® 5600 (IR CO_2). This robust and waterproof multi-gas meter is equipped with innovative infrared sensor technology and is ideal for personal protection.

For rooms requiring continuous monitoring of CO_2, the PointGard 2720 (IR CO_2) is ideal because it is a simple plug-and-play device with integrated audio and visual alarms.

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2. https://www.cdc.gov/niosh/nioshtic-2/20038645.html

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