Effects of Exposure to Carbon Dioxide Indoors on Human Comfort, Health and Performance

Recent experiments in the USA show that concentrations of carbon dioxide (CO₂) of 2,500 ppm can negatively affect cognitive performance in particular the decision-making. They suggest that CO₂ should be considered as the unwanted pollutant at concentrations likely to occur indoors. CO₂ is a human metabolite, thereby its main source indoors are humans. The indoor concentrations of CO₂ are between 400 ppm, which is a typical outdoor concentration, and 5,000 ppm, which is an occupational exposure limit. CO₂ is normally used as the indicator of poor air quality and the adequacy of ventilation in spaces occupied by humans. Concentrations below 1,000 ppm have been considered to indicate acceptable indoor air quality.

The main objective of the study supported partially by COWIfonden is to further examine whether CO₂ should be considered as a pollutant at the concentrations at which it occurs in public buildings and in homes, by examining not only the effects on cognitive performance but also on comfort and health and by studying the underlying mechanisms.

To meet the objective of the study, the experiments are carried out in a low-emission stainless steel chamber at the International Centre for Indoor Environment and Energy, Department of Civil Engineering (DTU BYG), Technical University of Denmark. Human subjects are exposed to different concentrations of CO₂ obtained by either artificially dosing CO₂ from the cylinders and keeping ventilation rates high, so metabolically generated CO₂ by the subjects during exposure is negligible or by reducing ventilation rates in the chamber, so that CO₂ produced by the subjects (and other emissions from humans, so called human bioeffluents) are increased. During exposure subjects assess their comfort including thermal response and the perceived air quality, acute health symptoms such as headaches, fatigue and irritation of nose, eyes and throat, and perform different psychological tests and tasks similar of office work to estimate whether their cognitive performance is affected. Physiological measurements are also performed of respiratory functions, pulse rate, blood pressure and stress biomarkers in saliva to examine the potential mechanisms underlying the effects observed.

The results obtained in the studies will contribute with the fundamental knowledge on whether CO₂ should be considered as the pollutant, and thus whether the currently used strategy to ventilate indoor spaces in which CO₂ is only an indicator of whether air quality is poor should be revisited.