Scientists work on innovative climate ventilation systems

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In the HiPIE laboratory (High Performance Indoor Environment), structural-physical parameters, such as acoustics, indoor climate and lighting, can be selectively influenced in order to explore their effect on people. Credit: Fraunhofer IBP

The inhabitants of Central Europe spend about 80 percent of their lifetime in buildings. With elaborate ventilation systems, researchers have provided a pleasant climate in homes and offices.

Unpleasant odors, stuffy air or permanent drafts: A person who is regularly exposed at home or in the office to bad air doesn't feel well. Odors from carpets, paints, varnishes and furniture, as well as mold, or air which is too dry, affect the indoor climate. "There are no materials without emissions and odors," explains Dr. Andrea Burdack-Freitag, sensory expert at the Fraunhofer Institute for Building Physics IBP in Valley near Holzkirchen, Germany. "Not all substances that are emitted into the air are harmful. However, sometimes we suffer from watery eyes, sore throat or headache." A trigger for such unpleasant consequences can be dry air or volatile organic compounds: VOCs for short (Volatile Organic Compounds), such as formaldehyde. VOCs are present in almost every component, such as in the form of solvents. "If complaints occur or if there is a continually unpleasant odor, we analyze the emissions that affect the air quality and we look for the cause," explains the researcher. To do so, she and her colleagues from the Chemistry and Sensor Technology Group employ sensors and measuring devices which have been specially conceived for air quality measurement.

New Indoor Air Test Center under construction

How is pollution through VOCs or CO2 distributed in a room? What are the flow conditions and how is the ventilation? Based on their investigations, the scientists develop ingenious ventilation systems together with industry partners. Later this year, the IBP researchers want to open the new Indoor Air Test Center. "There, we can purposefully pollute the air with biological and chemical substances as well as with particles of different sizes and shapes, produce temperatures of up to 80 degrees Celsius, increase the humidity to a maximum of 95 percent and regulate the air volume flows precisely. With the high-tech equipment, we want to test new filter technologies. We also construct complete office or home furnishings and then perform VOC investigations. We're also having the walls, floor and ceiling of the test rooms made of

emission-free materials," explains Thomas Kirmayr, Manager of the Climate Systems Group.

In the new laboratories, the scientists also want to work on innovative air ducts for special spaces, such as operating theaters. The new ducts should prevent, for example, that germs enter with the rising air in the operation area during surgery. In the Test Center, there is space for vehicles. As a result, the experts can also check the air quality in cars. These tests are necessary because there are a number of new composite materials in the vehicle models.

In what ways can it now be determined how good the indoor air is, or to what degree it has been consumed? "Until now, only a high concentration of CO2 could be an indicator of poor air quality. This value is measured by sensors, which report it to the ventilation system. We go one step further and investigate other parameters at the same time. In doing so, we use sensors to record the carbon dioxide, nitrogen oxide and ozone levels. We also rely on metal-oxide semiconductors that respond to food, drinks and human scents," describes Burdack-Freitag. On the basis of various measurement data, a ventilation control can respond more accurately than before, such as to stuffy air during meetings.

Which ventilation should be used in which building is one of the key issues during the planning phase of a new building. "In this process, it's important to keep in mind that air exchange rate and ventilation efficiency are two different parameters. The rate describes the air volume that flows into the room in one hour. If fresh air doesn't move through the room, but instead right back out through the window nearby, an effective exchange doesn't take place," explains Thomas Kirmayr, adding: "It has to be ensured in the planning that the air is actually exchanged. High resolution virtual models help to test these scenarios on the computer first. In this way, subsequent and costly building

conversion can be avoided. For the forecast, we at the IBP have developed the three-dimensional zone model VEPZO, with which room and ventilation planning can be assessed and resolved locally through visual representation."

The software can also be used for existing buildings. Based on the simulations, business people can then decide whether it is worth investing in a new or better ventilation system. The researchers at the IBP are also working on flexible systems that adapt to demands and recognize, for example, when some participants in a long meeting need fresh air. "One idea is to vary the air conditions of a room slightly, because people usually find that to be more enjoyable," says Kirmayr.

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