Medical Xpress

Air flow research could reduce disease, contamination spread

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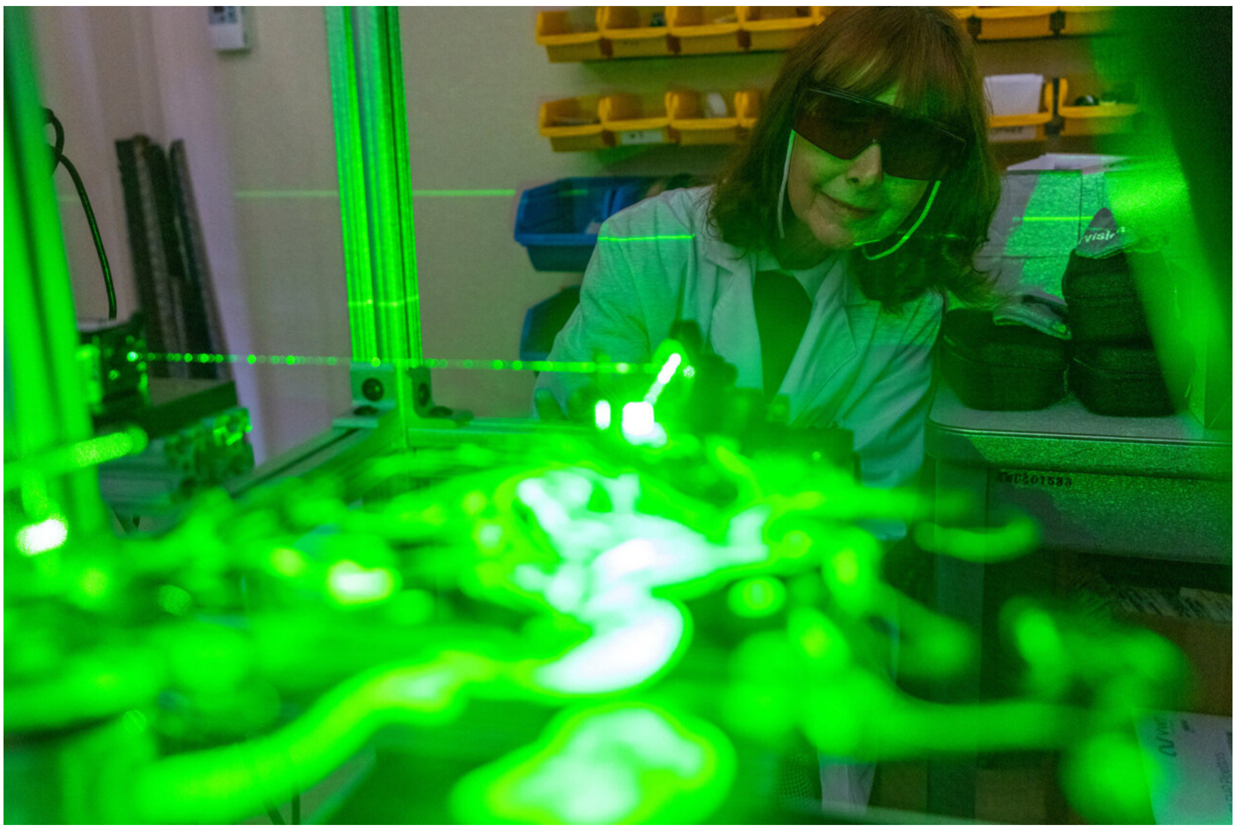


Maria King, Ph.D., director of the Texas A&M Center for Agricultural Air Quality Engineering and Science, watches on as simulated virus aerosol passes through a laser sheet that uses a high-speed camera to image and track the movement of the particles. Credit: Texas A&M AgriLife / Michael Miller

Air flow in a room can impact the transmission of viruses like

COVID-19.

A Texas A&M AgriLife Research scientist is studying how heating, ventilation and air conditioning, HVAC, system configurations and building designs could mitigate the spread of microorganisms, including viruses, that are detrimental to human health.

Maria King, Ph.D., director of the Center for Agricultural Air Quality Engineering and Science in the Department of Biological and Agricultural Engineering, will study the aerial paths of pathogens in health care facilities. The study should shed light on a largely invisible aspect of building design that has a large impact on human health.

King said the study bridges scientific disciplines including biology, virology, computational modeling and engineering to applied research in an exciting and innovative way. The study also comes after the world has spent several years dealing with outbreaks of COVID-19, which primarily spreads through the air.

This innovative engineering perspective is making a big impact on the way facilities look at air flow design, King said.

"Using engineering to look at life science problems is making a big difference in how we look at disease prevention," she said. "We're realizing the potential that engineering tools and perspectives can present to addressing sanitation or taking on microbes and organisms that impact human health."

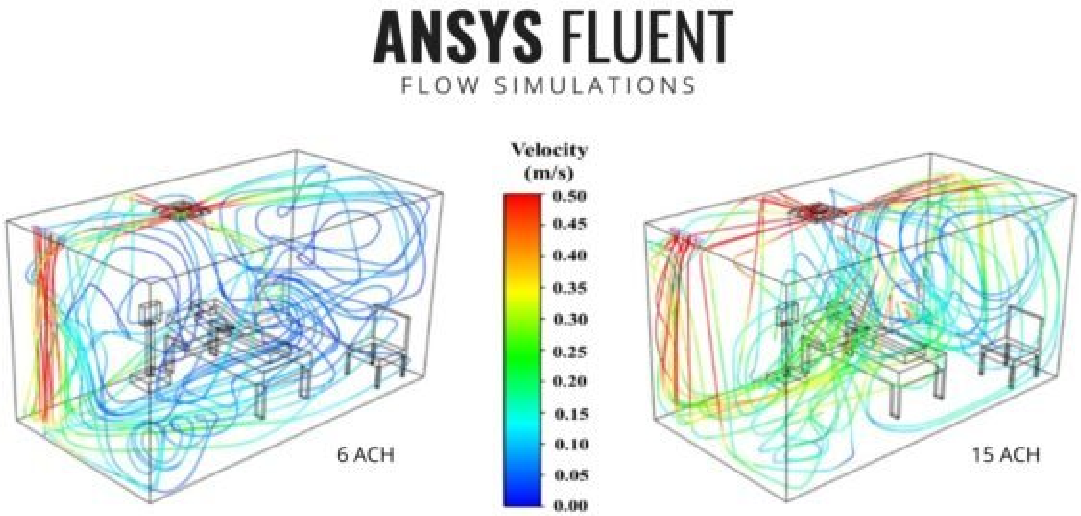
Interdisciplinary research uses models, simulations to pattern air flow

Ventilation systems are a part of most built environments, so the effect of air properties on aerosolized viruses is critically important to study. Researchers will use air flow modeling and simulations to visually pattern how pathogens can move within a space based on the various factors. King's study will answer fundamental questions related to that movement.

King hopes the new project can educate scientists and engineers about how viruses transport through a space in various bioaerosol forms, such as droplets from a cough or sneeze.

The goal is to help develop and implement interdisciplinary ventilation strategies and guidelines within design, management and monitoring of diseases in healthcare facilities and that can be applied to other built environments.

Furthermore, the team seeks to learn how factors such as temperature, humidity and air velocity transport droplets of various sizes through spaces with varying configurations, dimensions, surface characteristics and other features, she said. Understanding the conditions that contribute to higher exposure to pathogens can direct designs that reduce pathogens' entrainment and spread.



This ANSYS Fluent flow simulation for a three-quarter scale ventilated hospital model room with air intake above the patient's head and exhaust at left below bed shows how bioaerosols move under different ventilation velocities. On the left, lower air exchange leaves the patient's breathing zone clear of air velocity streamlines that could carry pathogens. On the right, higher air velocity creates more turbulent vortices above the patient's head, leading to potential extended exposure to aerosolized pathogens. Credit: Texas A&M AgriLife / Leon Contreras / Maria King

King has previously shown that combined modeling and sampling approaches can mitigate the movement of airborne infectious microorganisms through ventilation.

For instance, King studied air flow within a meat processing plant with modeling simulations to show how barriers, much like the clear plastic shields at check-out counters in grocery stores, might impact pathogen spread between people working near each other along a processing line.

The modeling showed the barriers affected the air flow but that additional shielding above each worker would measurably improve protection.

King said air flow modeling and simulations take an incredible amount of data inputs and sophisticated computational technology in the Texas A&M High Performance Research Computing group resources to correctly visualize air flow patterns. The research team will also use high air volume bioaerosol collectors to investigate how viruses might spread throughout an HVAC system with different intake and exhaust configurations and air exchange rates.

In addition to King, the research team also includes Sandun Fernando, Ph.D., P.E., who was recently appointed to the Dow Chemical Endowed Professorship, and Zivko Nikolov, Ph.D., P.E., both in the Department of Biological and Agricultural Engineering. Another member of the team is Gabriel Hamer, Ph.D., associate professor in the Department of Entomology.

The team will also conduct experiments in a 3/4-scale model of a ventilated hospital room and in real hospital settings.

"The most exciting aspect of this study for me is the expertise of our team and the technologies and unique facilities we are using to learn more about the complex challenges this research presents," King said. "Innovative research starts with the right team, and we have a great interdisciplinary team and complete support from the department and the College of Agriculture and Life Sciences. It is a very synergistic work environment."

Rethinking building, HVAC configurations

The simulations and modeling have already revealed that certain aspects of ventilation, such as the impacts of building design or the number of air changes per hour, ACH, can be counterproductive for sanitation or infection prevention.

For instance, a hospital might adopt a high ACH under the assumption that airborne particles would be removed more rapidly, King said. But, depending on the layout, the ACH may move the particles around the room like a blender, which greatly increases exposure.

In another example, at one meat processing plant, the HVAC air intake units were located near the cattle holding pens. The intake location increased the chance that unwanted bacteria, fungi or other microorganisms could impact sanitation in sensitive areas within the meat processing facility.

King said that while the study focuses on health care facilities, the research has innumerable applications, including for schools, food processing industries, grocery stores, offices and military installations.

"The examples might seem obvious now, but they were not considered from this air flow perspective when the facilities were configured," King said. "These examples illustrate the value of understanding how modeling can help optimize specific goals at the design and planning stage of building. So, we are excited to see where this study takes us because we believe these discoveries are very important to critical infrastructure and also applicable to everyday aspects of our lives."

Provided by Texas A&M University