Sustainability

Reducing Laboratory Building Energy Use

Wed, 08/02/2017 - 9:26am by Gordon P. Sharp, Member ASHRAE, Aircuity Inc.

Laboratory research facilities have extremely high energy costs, due primarily to the vast amounts of 100 percent outside air required to meet minimum ventilation or air change requirements. Reducing facility and energy expenses has become a critical challenge for both new and existing lab and vivarium facilities. Equally important is reducing carbon footprints, meeting green building goals, and providing a better indoor environment.

Until recently, there has been very little objective data on how reducing or varying air change rates would affect energy savings. To address this gap, the American Industrial Hygiene Association (AIHA) conducted a major research study on the indoor environmental quality (IEQ) conditions of 300 lab areas and vivariums that are using dynamic control of air change rates. The study demonstrated that laboratories can use lower air flow rates with an automatic air change rate control system for well over 97 percent of the time.

OPTIMIZING OUTSIDE AIR EXCHANGE RATES

The primary reason behind high laboratory energy expenses is the amount of outside air required for facility ventilation. Particularly for life sciences labs and vivariums, air flow is often dictated by the minimum air change rate

may be from 6 to 12 ACH in a lab room or 12 to 20 ACH in a vivarium. This (somewhat arbitrary) ACH rate is often way too high – If the air in these rooms is "clean," or free of any harmful or irritating contaminants, such high air change rates are often not necessary, at least for times when the air is clean.

One approach that has been shown to effectively and safely vary air change rates in labs and vivariums is to use a sensor to detect the air quality for such contaminants as total volatile organic compounds (TVOCs), ammonia, plus some other chemical vapors and odors, as well as particulates. When the sensors indicate that room air is free of these contaminants, the air change rates can be reduced, possibly to as low as 2 to 4 ACH for a lab and 4 to 6 ACH in a vivarium.

VARYING AIR CHANGE RATES

The AIHA study on laboratory ventilation is believed to be the largest ever conducted on laboratory and vivarium IEQ conditions. It covered more than over 1.5 million hours of lab operation in more than 300 lab areas at 18 different facilities. The study collected and analyzed more than 20 million sensor values, including data on TVOCs, particles ranging from 0.3 to 2.5 microns, carbon dioxide, and dewpoint (absolute humidity). Facilities in the study were primarily life sciences and biology-related areas, along with a smaller number of chemistry and physical sciences lab areas.

The study used multiplexed sensing, which was considered the most economical and reliable approach to sensing environmental conditions in many labs and vivarium rooms within one facility. One central set of sensors was used to sense many different rooms or areas. Every 40 to 50 seconds, a sample of air from a different area was routed through a common air sampling backbone (a hollow structured cable) to the centralized set of sensors (known as a sensor suite). There it was measured, and these sequential measurements were then "de-multiplexed" for each sampled area to create distinct sensor signals used for traditional monitoring and control. Typically, 20 to 30 areas can be sampled with one

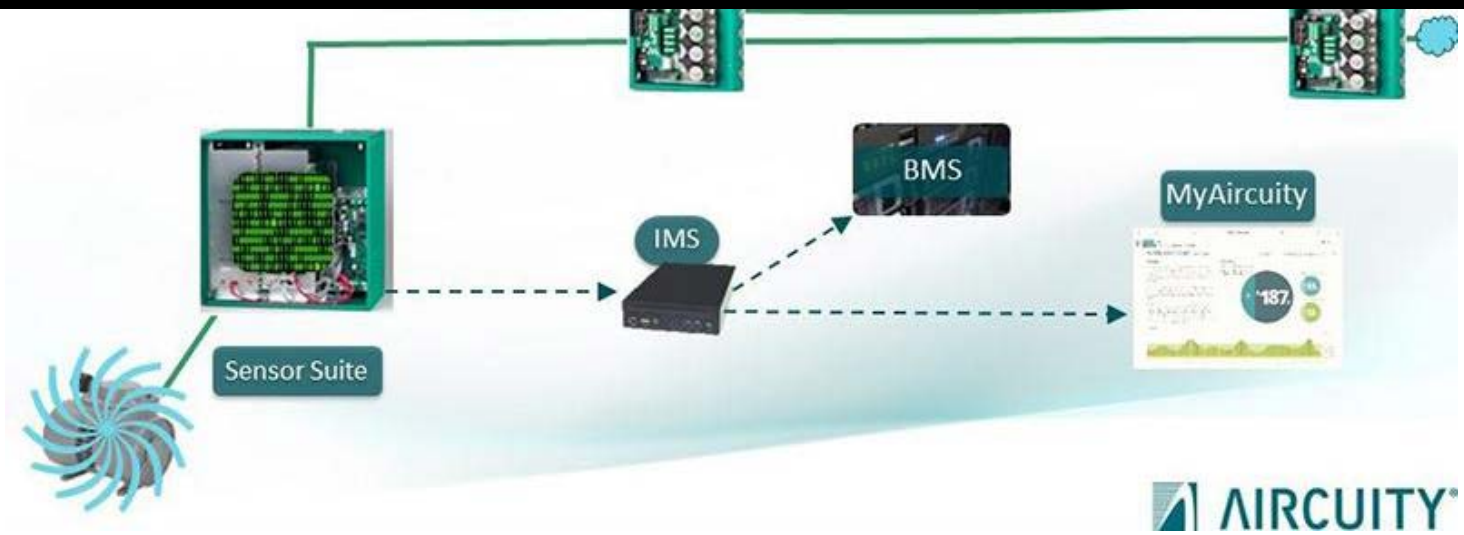

Figure 1 shows an example of t

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This multiplexed sensing concept reduced the number of sensors needed to implement this methodology by a factor of nearly 30. It also improved the accuracy of different contaminant or parameter measurements. For controlling the lab room space airflow and IEQ it is usually best to look at the contaminant levels in the room differentially, subtracting the contaminants in the supply airflow from the exhaust or room levels. Any sensor offset drift error will be the same for both measurements, since the sensor is the same for both measurements. That means the offset drift error of each is cancelled out.

LABS ARE CLEAN

Study results, shown on Figure 2, concluded that labs are typically “clean” of most chemical contaminants about 99.2 percent of the time. This suggests that facilities will save energy by

operating at reduced minimum air change rates the majority of the time with respect to the TVOC sensor.

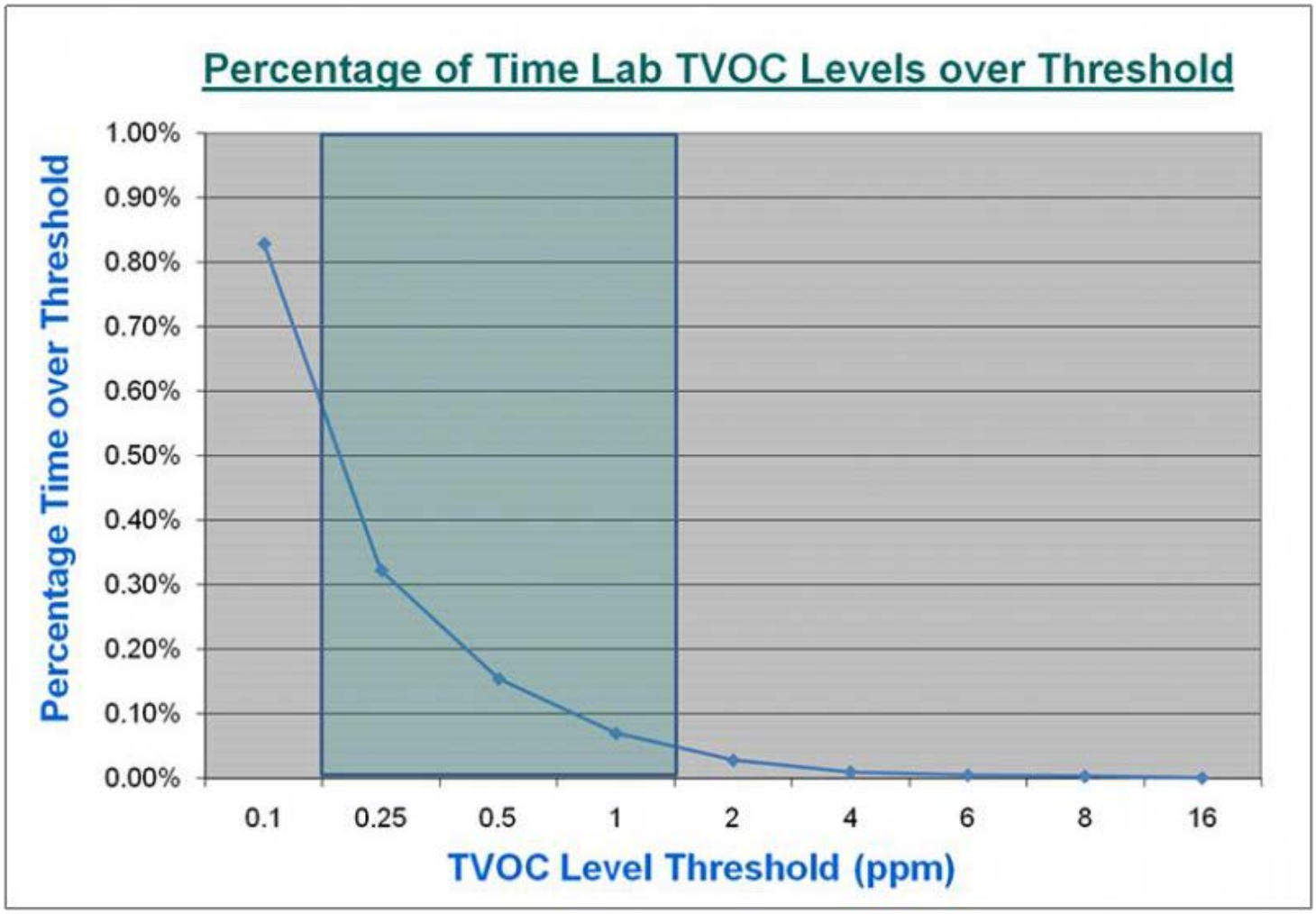

Figure 2: Study results

showing that a lab's area typically "clean" of most stochemical con

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Figure 3 shows the average TVOC level percentages for multiple lab sites. Even at the site with the greatest amount of TVOC activity, the dynamic control concept can still save energy about 97 percent of the time.

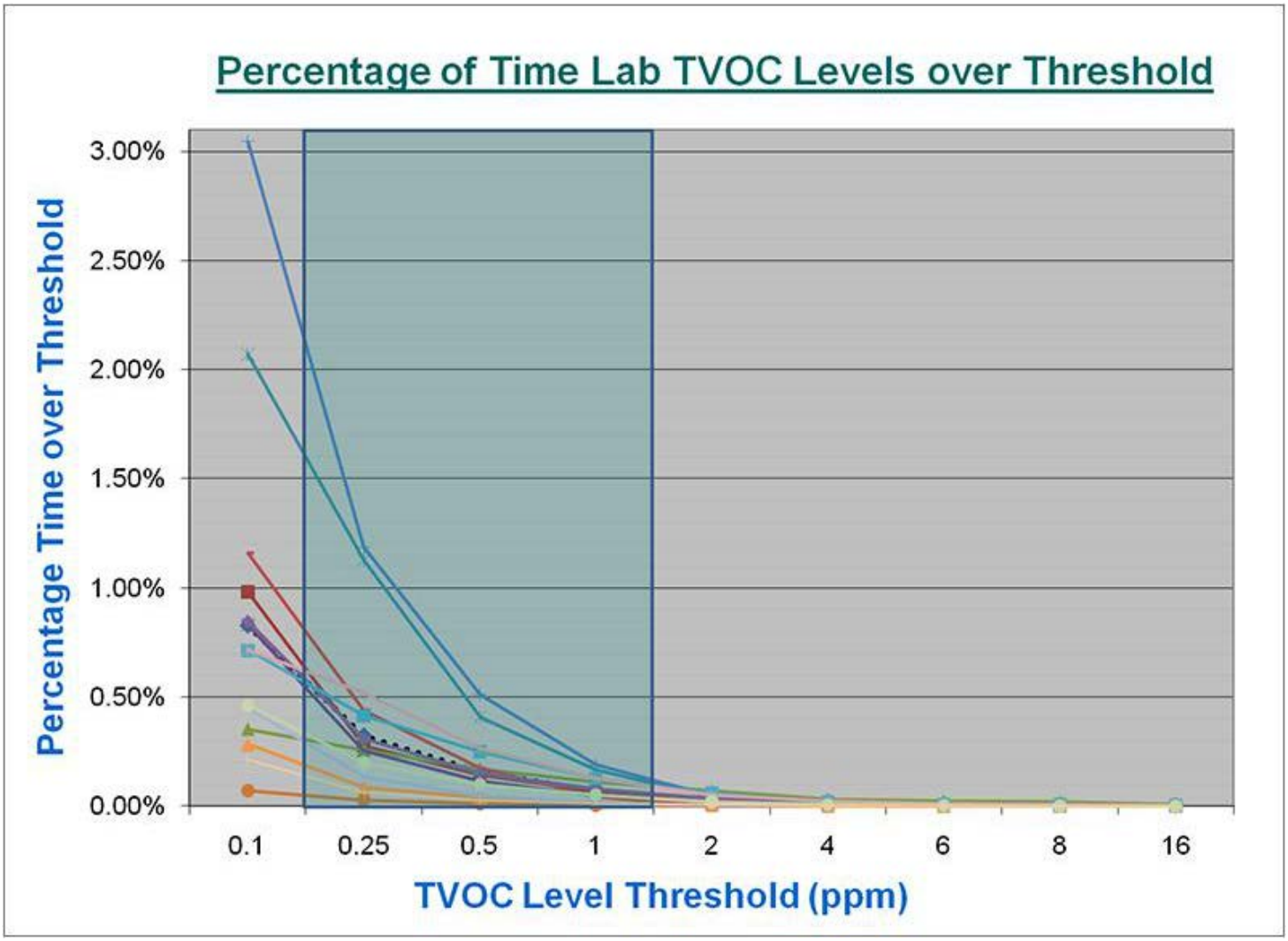

Figure 3 shows the average T

VOC level percentages for multiple lab sites.

Particles are another parameter that can cause an increase in the minimum air change rate. This could be due to a reaction that goes out of control, an acid spill that causes an evolution of smoke, or perhaps an aerosol into the lab room. The graph on Figure 4 shows the percentage of time that small particle levels exceed the threshold at various lab sites. The average lab room (shown by the dotted black line) is above the 1 million particles per cubic foot (PCF) threshold about 0.5 percent of the time, an average of only about 30 minutes per week.

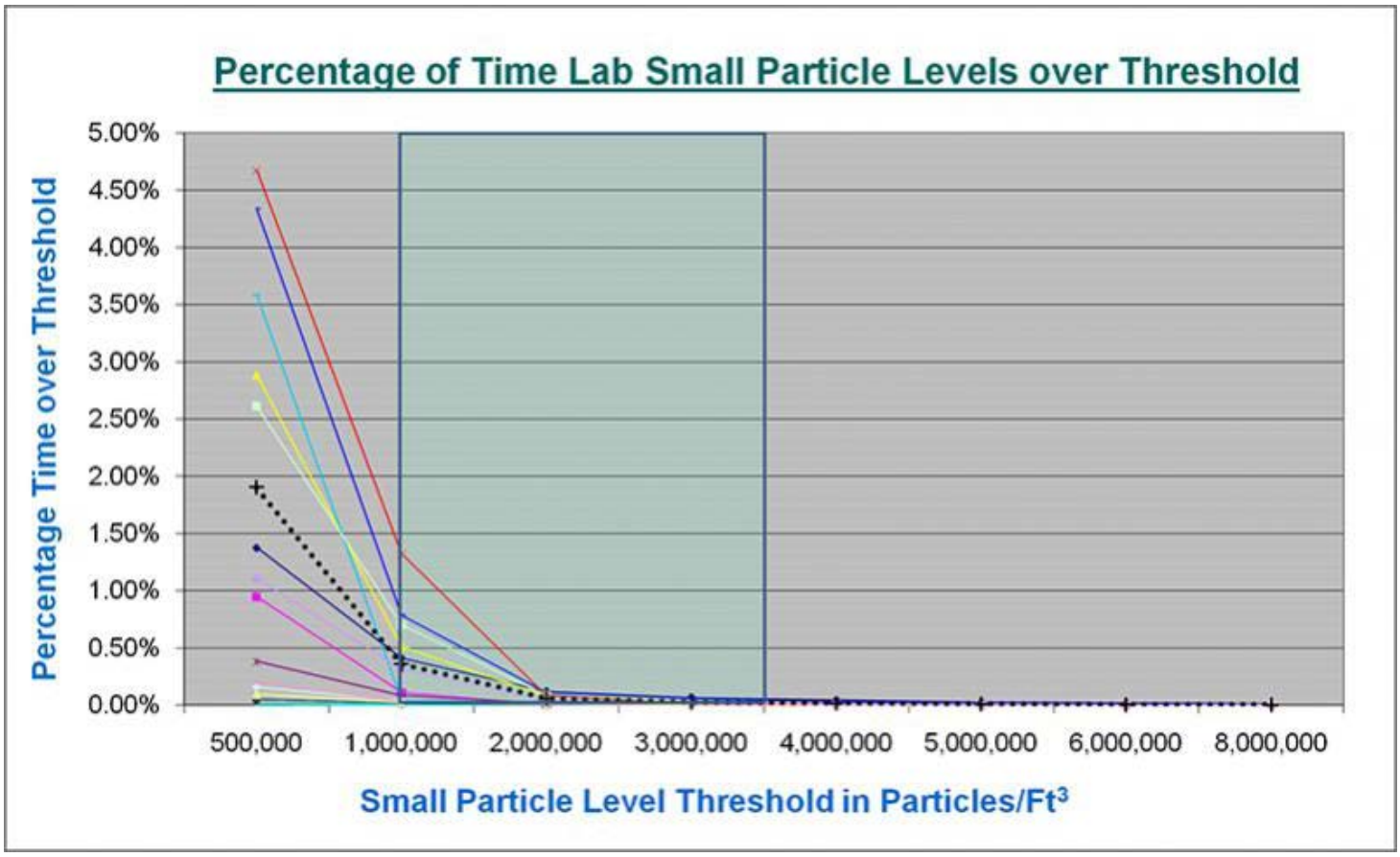

Figure 4 shows the percentage of

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The information indicates that airflow should be increased based on a particle event from a low of nearly zero percent of the time to about 1.5 percent of the time. If one adds this to the time TVOCs are above the control threshold, it adds up to a need for increased airflow for only an average of 1.2 percent of the time, an average of up to about 5 hours a week.

LOWER FLOW RATES

TVOC and particle events that require high ventilation rates occur only a few hours a week. Minimum air change rates of between 2 to 4 ACH are adequate to handle either TVOCs or particle events from 97 percent to more than 99.0 percent of the time. The study indicates that facilities can use much lower flow rates with an automatic demand-based ACH rate control system.

One example is the Aircuity 2.0 platform, which was designed for research laboratory facilities looking to significantly reduce energy costs, monitor space conditions and occupant behavior, and achieve quantifiable savings that can be reinvested in research. The web and desktop apps give laboratory facility managers implementing airside efficiency actionable insights, transparency, and accountability. Moving beyond simple data trends, the platform offers deep analytics of cost and energy savings, indoor environmental quality responses, and occupant behaviors. The user interface presents the highest priority information for each stakeholder, on demand or delivered to their inbox or mobile device.

Many organizations are facing challenges concerning reducing their carbon footprint and their usage of energy. Airside efficiency is one of the highest total return on investment energy conservation measures available. This research provides evidence that demand based control of lab air change rates can make significant contribution towards safely meeting these goals and creating measurably better environments.

Gordon Sharp has more than 25 U.S. patents in the fields of energy efficiency and laboratory controls. In 2000, Gordon founded Aircuity, which was spun out of Honeywell. He is a member of the board of directors of the International Institute for Sustainable Laboratories, the nonprofit foundation that officially cosponsors and operates the Labs21 conference.

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