August 2010 Vol. 52, No. 4

Advantage Business Media

R&D™

TECHNOLOGIES & STRATEGIES THAT ENABLE RESEARCH & DEVELOPMENT

www.rdmag.com

LABORATORY ENVIRONMENT

# Airing Out Laboratory HVAC

A fresh flow of air supply solutions could answer one of the leading design conundrums facing laboratory designers.

An HVAC engineer's prime concern when planning or constructing any laboratory building is the safety of the building's occupants. The system must operate to specification and meet appropriate regulations. To this end, many older laboratories were designed with little regard to energy efficiency. That's no longer true, and designers must account for operating costs as well as functionality.

A typical laboratory building consumes five to ten times more energy than a typical office building or school. HVAC systems consume almost 70% of a laboratory's energy, according to **Labs21**, a voluntary partnership program dedicated to improving the environmental performance of U.S. laboratories. The majority of this HVAC energy consumption originates from cooling (22%) and ventilation (44%) loads that help the laboratory function safely.

"This high energy use can be attributed to high outside air requirements, large internal heat gains from laboratory equipment, and, in many cases, continuous hours of operation," says Jeffrey L. Linde, PE LEED AP, **Newcomb & Boyd**, Atlanta, Ga.

With a push toward a more energy-efficient laboratory environment, vendors are developing new technologies—or adapting older ones—to help reduce HVAC energy consumption. Before they can apply their expertise, questions must be answered. What HVAC techniques or technologies can reduce energy use? How effective are they? How much do they cost? Can these technologies be improved?

### The problem with extra air

Lighting and electrical loads account for 11% and 23%, respectively, of a lab's total energy consumption, according to Labs21 data. But the lion's share of a lab's electricity bill is connected to the need for plenty of outside air. This impact, in relation to the total HVAC energy consumption of a typical lab, is about 80%, or about 60% of the total energy use of the lab building, according to Gordon Sharp, chairman of **Aircuity**, Newton, Mass. The metric with the most impact on lab HVAC system efficiency is the minimum air change, which can vary.

The U.S. Environmental Protection Agency's minimum recommendations range from 4 to 12 air changes per hour (ACH).

"The overall energy consumption of any laboratory is closely tied to its minimum air change rate, which makes the difference between 4 ACH and 12 ACH almost triple the energy consumption," says Linde.

A common strategy to mitigate outright energy use is take advantage of the gap in energy or heat between the outgoing exhaust air in a laboratory and the incoming supply air. Technologies that attempt to leverage this differential include air-based systems such as run-around coils, heat pipes, cross flow heat exchangers, heat wheels (mainly enthalpy wheels)—and chilled beams, a chilled water-based system.

When these approaches are implemented individually, results can be seen but are often incremental. According to various lab design experts, the appropriate approach for a sizable reduction in laboratory energy use is to take a holistic or integrated systems approach to energy-efficient technologies.

"Combining different technologies can often create a situation where the whole is greater than the sum of the parts," Sharp explains.

A good example are active chilled beams, which have been used in European facilities for several years, and just recently gained traction in the United States. Chilled beams are ceiling-mounted diffusers that use building supply air to induce room air to pass through an integral water coil. The induced room air is cooled by the coil above the ceiling tile to provide local cooling in the laboratory.

This additional local cooling nets three main positive effects for a lab's HVAC system—reduced supply air flow, less reheat energy, and lower system first costs. However, with typical fixed minimum dilution ventilation rates of 6 to12 ACH, a good amount of conditioned air still has to be brought to the lab, even at the lower end of this range.

"Where cooling loads are low to moderate, this might increase energy consumption due to the extra fan power and reheat energy that would be required for that redundant air flow," says Sharp. A demand-based control system can reduce the ventilation requirements and air flows to between 2 to 4 ACH of air flow, he explains. The chilled beams can then handle the cooling load above this point to save fan energy and reduce reheat.

## Energizing incentives

In the past, laboratories did not take many or any steps to monitor energy use beyond the review of electric, gas, and water bills. As large consumers of energy, laboratory owners are learning that they can benefit from the Leadership in Energy & Efficient Design (LEED) green building certification program by U.S. Green Building Council.

The program encourages both energy-efficient and environmentally-friendly building features and offers credits toward certification for building features or techniques. The guidelines to measure and verify energy savings have motivated lab owners to install more elaborate energy metering systems to track ongoing energy consumption. The information collected can be compared to the performance predicted by a calibrated computer model of building energy use, potentially leading to large energy savings.

To meet goals set forward by programs such LEED, Labs21, or even a lab owner's bottom line, better air management systems have been in constant development. These are typically systems-based approaches that either evolve from established air management practice or rely on new technologies such as sensors and embedded systems. One such solution is the centralized demand-control ventilation system (CDCV).

In a typical demand-based control system, sensors are placed in each room in the lab to measure contaminants and make system adjustments in real time. A CDCV uses a different approach. A sample of each room's lab exhaust air is captured and brought to a centralized sensor suite for analysis.

In the case of Aircuity's OptiNet CDCV system—illustrated above—every 40 to 50 seconds a sample of air is routed through a common air sampling backbone—a tube within a structured cable—to the sensor suite for measurement. These sequential measurements are then "de-multiplexed" for each sampled area to create distinct sensor signals that can be used for monitoring and control.

The number of required sensors is reduced by a factor of 20. Monitored labs can run overall air change rates as low as 2 ACH when the air is clean, but can increase the airflow rates to 8 to 16 ACH when contaminants are sensed.

The OptiNet system was used in the Feigin Center of Texas Children's Hospital, a facility recognized in *R&D Magazine's* 2010 Laboratory of the Year competition. But not every lab requires the latest in air-handling technology to benefit, and many labs simply transfer from constant air volume (CV) reheat systems to variable air volume (VAV) technology.

Over the past 25 years, VAV systems have largely displaced CV as the HVAC approach of choice for labs that require a significant throughput of outside air. The VAV system takes advantage of the fact that cooling loads in most laboratory spaces are not constant. As the cooling load decreases from its design peak, the need for supply air also decreases.

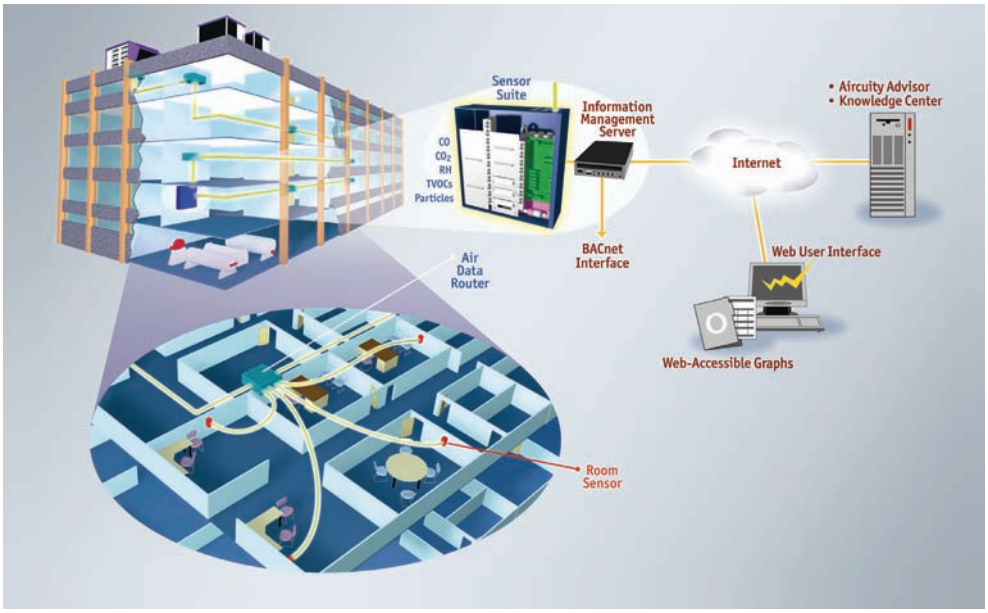


**Diagram shows how Aircuity's OptiNet technology works within a laboratory setting.**

"The decrease in supply air is accomplished with variable frequency drives that control the speed of the supply fans. The energy consumed by these fans decreases as the supply air capacity decreases," says Linde.

## The need for speed control

As the need for supply air decreases, so does the need for general exhaust. A VAV exhaust air sys-

tem uses variable frequency drives, which use less energy than constant speed drives, to control the exhaust fan speeds.

**Siemens Building Technologies**, Zug, Switzerland, manufactures a line of variable speed drives, called SED2. This, according to Jim Coogan, principal application engineer at Siemens, "is one of the biggest energy savers that can be implemented into a laboratory setting." The technology's low harmonic disruption to the power quality of other equipment and small footprint set it apart from other variable speed drives, he says.

If a laboratory distributes AC power continuously at a steady frequency of 60 cycles per second, the SED2 will vary the speed of motors by varying the power that comes from the power source. The motor will turn at a different speed, lowering overall power and energy consumption.

When a VAV system reduces the air flow rate in a laboratory, "it saves energy at every component in the HVAC system," says Coogan. "VAV systems are also likely to reduce the need for reheat in a room, so the energy saved at the reheat coil is actually saved twice."

## Fixes for existing systems

In addition to the previously mentioned strategies, laboratory fume hoods can also help mitigate airflow requirements in labs. While fume hoods primarily are safety devices, energy savings and safety don't have to be mutually exclusive.

A lab using a CV exhaust system with standard fume hoods operating at 100 fpm baseline face velocity has several choices to raise efficiency, says Bob DeLuca, Jr., vice president—technical products at **Lab Crafters, Inc.**, Ronkonkoma, N.Y. The first are high performance hoods operating at 50 to 60 fpm face velocity.

"High efficiency, low-air-volume hoods, also known as low velocity hoods or high performance hoods, are designed to operate with lower volumetric flows and low face velocities compared to conventional hoods," says DeLuca. These hoods can reduce the heating/cooling demands on the HVAC system without operator interaction required. However, savings can only be seen in laboratories where all loads in an HVAC system are driven by the hood population and density, DeLuca says. These hoods work well with both CV and VAV systems.

**Kewaunee Scientific, Inc.**'s, Statesville, N.C., Supreme Air LV fume hood is one example and was designed to operate safely at a face velocity as low as 55 fpm vs. the 100 fpm of a conventional hood.

"The sash on an LV hood locks open to full height for set up procedures then self-closes to 18 inches for normal operation, allowing a VAV system to exhaust air at a reduced rate," says Kurt Rindoks, vice president of engineering and product development, Kewaunee Scientific. A Cartesian baffle system, a dynamic barrier bypass, a flush airfoil, and a new shape for the sash handle and fascia panels achieve the energy efficiency.

A second alternative, according to DeLuca, is a two-position exhaust system, which has one designated airflow during occupied time and another when the hoods or lab are not in use. These two-position systems "can incorporate standard fume hoods or high performance fume hoods for greater efficiency," says DeLuca.

One of the most common solutions in today's laboratories is to install a VAV fume hood, which can modulate between maximum and minimum set-points for fpm as the fume hood sash position is adjusted by the user. By reducing the size of the operating sash opening, a lower exhaust flow is required of the HVAC system. **American Auto Matrix**'s (Export, Pa.) Auto-Flow, a fume hood control system, can automate these sash adjustments.

"With our Auto-Flow controller, one can implement sash-pots, face velocity and exhaust duct sensors, hood presence detectors, and even select the damper style preferred," says Paul Jordon, CTO, American Auto Matrix. "The ability to have full and complete control over what is running in a laboratory is crucial to saving energy and money."

The demand for energy efficiency, highlighted by spiraling utility expenses and incentives offered by government agencies, has created a new demand for lab owners: control. By exercising control over an HVAC system, whether through a Supreme Air LV fume hood for an existing CV system, an Auto-Flow controller for a VAV installation, or an OptiNet CDCV, the energy savings can be realized.

**— Lindsay Hock**

Posted from R&D, August 2010. Copyright © Advantage Business Media. All rights reserved.
#1-28060500 Managed by The YGS Group, 717.505.9701. For more information visit www.theYGSgroup.com/reprints.

AIRCUITY®

**Aircuity, Inc.**
39 Chapel Street
Newton, MA 02458

1.866.602.0700
617.641.8800 ph
617.969.3233 fax

Safe, Smart & Efficient Airside Solutions
www.aircuity.com