Going Green: Reducing Laboratory Operating Costs by Reducing Airflow for Greater Energy Efficiency

By: Sam Colucci, PE & Patrick Boccio, PE, IPS

The laboratory may be the heart of discovery and innovation, but it is by far the largest consumer of energy in any pharmaceutical or biotechnology operation. With its massive demand for outside air, a laboratory can generate energy costs that are more than double those of a manufacturing facility and four to six times higher than the costs for a typical office building. Reducing airflow can save energy costs associated with supply and exhaust fans, heating, cooling and dehumidification/humidification. In fact, smart sustainable design can often reduce energy costs by 30 to 50 percent without compromising safety or science. A methodical review of a laboratory's operations—focusing on primary and secondary containment and equipment—can often reveal simple, cost-effective design criteria changes that can result in significant savings.

Optimize airflow at the bench
Proper selection and utilization of primary containment equipment can reduce air-handling costs without compromising safety. The level of risk and actual operations will drive the choice of containment strategies. When you consider that one six foot fume hood uses as much energy as three average homes in America the reduction of minimization of exhaust volume is particularly beneficial in reducing facility energy costs as well as minimizing the impact on the facility infrastructure. Often, simple initiatives can result in improvements. For example, annual inspection of fume hoods can increase safety and reduce costs associated with improper functioning.

Strategies for facilities with constant air volume fume hoods

- **Base exhaust airflow on an 18-inch sash height** and place stops at or above the high where face velocity drops below 80 feet per minute (fpm). This can reduce turbulence and, therefore, energy and airflow.

- **Rebalance hoods** that are designed for 100 fpm with the sash full open to 90 fpm with an 18" sash position.

- **Select sashes that achieve the best balance of containment, ergonomics and energy efficiency.** With a smaller open area, horizontal sashes generally require less airflow that vertical sashes of the same size; combination sashes offer the benefits of energy efficiency and ergonomics.

- **Consider two- or three-position terminally controlled systems.** Although first costs are higher for these than for hard-balanced systems, lifecycle costs are more attractive, particularly if the facility will be in operation for more than five years. Two-position systems reduce airflow volume when the facility is unoccupied. Three-position systems add the ability to reduce fume hood exhaust volume when a sash is closed in an occupied building.

- **Consider low flow fume hoods** Low flow fume hoods have gained acceptance and have been proven to be safe when applied properly. There are many variations of these devices which often cost almost double what a conventional fume hood costs but you can't beat the simplicity that they afford for fume hood exhaust driven constant volume laboratories.

Alternatives to constant air volume fume hoods

- **Variable air volume (VAV) fume hoods offer the lowest energy costs when used properly.** These hoods continuously measure and adjust the exhaust air volume based on the face velocity or sash position. Despite a higher cost for controls, VAV hoods are a good choice for operations that require high quantities of fume hoods, and ASHRAE 90.1 requires VAV hoods in systems greater than 15,000 cfm unless a heat recovery system is applied. VAV laboratories have the added benefit of reducing simultaneous heating and cooling by delivering the right amount of air to the laboratory rather than a constant amount of airflow with continuous reheat. This significant consumption of energy is often overlooked when return on investment studies are considered.

Strategies for biosafety cabinets

- **Select adequate protection without overprotecting** in order to reduce exhaust air volumes. Doing so can also reduce pressure drop, fan energy and excessive noise. For example, a Class II, B1 cabinet exhausts 430 cfm of air, while a Class II, B2 cabinet exhausts 1,000 cfm and requires the entire exhaust system to operate at a high enough pressure to pull the exhaust air through the biosafety cabinet HEPA filter. Class II, Type A2 cabinets are acceptable for most applications and can return air to the room in most instances.

- **Weigh the relative benefits** of cabinet cost, operating cost, required decontamination and highest level of use with input from Environmental Health and Safety and other stakeholders.

Strategies for local exhaust ventilation

- **Close off unused point exhausts** for immediate payback.

- **Use a plastic hose or flex duct for end connections** to reduce resistance, lower pressure drop and enhance ergonomics.

Create an energy efficient environment
Evaluating room-level criteria such as air changes and heat load can often identify factors that can be adjusted to provide immediate savings without significant capital investment.

Air requirements

- **Use fan coil units, chilled beams or recirculating air systems for ancillary spaces** to reduce the cost of supply air for heat load generated spaces

Going Green *continued*

where biological and chemical aerosols are not present or are contained. These strategies can be used to supplement once through systems as well to maintain desired air changes where heat load exceeds air change requirements.

- **Reduce transfer air quantities from corridors to laboratories** to generate savings for each door. Typically, 100 cfm is adequate to maintain directional airflow with doors closed.

- **Determine the minimum air change rate required** based on the hazards in the laboratory. This should be done in consultation with an Environmental Health and Safety expert.

Temperature and humidity

- **Identify an acceptable range for temperature and relative humidity** based on an understanding of how those factors affect the products, equipment and research. It may be possible to generate significant savings by changing set points.

- **Accurately estimate head loads** to reduce the need to reheat supply air. VAV systems are designed to reheat supply air only as necessary. With constant air volume systems, consider local metering and discharge temperature sensors to obtain accurate system data, rather than basing calculations on lighting and equipment loads.

- **Reduce lighting power densities** by evaluating illumination needs in order to reduce cooling loads and lighting power costs. Consider using high-efficiency luminaries and lamps, laying lights out more efficiently, harvesting daylight, and incorporating timers and/or occupancy sensors.

Enhance equipment performance and reduce life-cycle costs
Proper selection and maintenance of equipment can optimize performance and energy efficiency. For example, using filters with more media via V-pleats or other technologies and implementing optimal change-out procedures can reduce pressure drops and lower life-cycle costs. Similarly, air systems with variable frequency drive (VFD) motors are more efficient than systems with inlet guide vanes.

Adding variable geometry discharge dampers can reduce exhaust fan power requirements by making it possible to control exhaust duct static pressure and maintain constant stack velocity. Resetting the static pressure set point at an optimal level can save up to 15 percent in annual energy costs. Proper air system maintenance can also support better chilled water system performance by minimizing conditions that result in low delta T syndrome.

In addition, a heat recovery system can reduce energy costs, particularly in facilities that must exhaust 100 percent. Although these systems involve hard and soft costs, rising energy prices make them increasingly attractive. Several types are available, including run-around loop systems, fixed-plate exchangers and enthalpy wheels. The technology selection should be based on risk assessment, operational requirements, climate and other factors.

2009 ISPE International Events

Jul 14	San Francisco/Bay Area Chapter Commuter Conference - San Francisco, CA
Aug 14	Rocky Mountain Chapter Golf Tournament - Brighton, CO
Aug 17	Boston Area Chapter Golf Tournament - Middleton, MA
Aug 27	Puerto Rico Chapter GAMP COP Forum & Technology Showcase - San Juan, PA

For more information: www.ispe.org