Fume Hood Exhaust Systems Made Energy Efficient

By Janet Bixler

Boehringer Ingelheim Pharmaceuticals Inc. receives the FAME Award of Excellence for designing energy efficient fume hood exhaust systems.

Discovering new treatments and possible cures through biotechnical research that will help define the practice of medicine throughout the 21st century is the principal mission for the people of Boehringer Ingelheim Pharmaceuticals Inc. As part of a global enterprise with operations on five continents – six in the United States – Boehringer Ingelheim's U.S. activities are coordinated from a 300-acre site in Ridgefield, Connecticut, which is the principal research and development center for North America. The research group in Ridgefield has been designated as a center of excellence for Boehringer Ingelheim's global program of discovery in the areas of immunology and inflammatory diseases.

The Boehringer Ingleheim research and development campus consists of nine buildings, totaling 1.3 million square feet. Four of these buildings are occupied with research and development laboratories for the company's 3,600 scientists and technicians. Research work is demanding, expensive and risky, therefore it is imperative that Boehringer Ingelheim provide excellent work conditions in its highly sophisticated facilities. So, when the scientists met with the facilities engineering department in 1989 to discuss their need for more space, a plan was initiated. Their efforts were recognized in October at *Facilities America* '96, AFE's annual conference, where the company was honored with the Facilities Management Excellence (FAME) Award of Excellence.

Energy efficient: *To protect scientists, fume hoods are supplied with exhaust fans, which move air at a rate of 100 feet per minute past the scientist and through the hood.*

FUME HOOD CONTROL

The project included the construction of two laboratory buildings at a cost of $32 million of which $5 million was to be spent on HVAC services. Once the engineering team determined how many people needed to be accommodated and how many fume hoods were needed, the engineering team hired an architectural firm and an engineering firm to work on design and construction as a team.

"The two buildings, Buildings 6 and 7, were definitely going up and the facilities engineering department realized the already terrific energy use of the other buildings," said Louis J. Monte, project engineer at Boehringer Ingelheim. "We wanted to find a new system that would not use as much energy." Compared to a building with an office-type occupancy, a research and development facility typically requires much more air flow. The supply air flow required by an office building is usually determined by the space cooling loads. However, in a fume hood intensive laboratory building, the supply air quantity is driven higher because it also has to make up the air exhausted by the fume hoods. For example, a space with four fume hoods, which may require 1000 cfm of supply air to satisfy the cooling load, may require up to 5600 cfm supply air to replace the room air exhausted through four fume hoods.

In addition to the energy costs associated with the increased airflow requirements, research and development facilities require the use of 100 percent outside air for supply air to the laboratories. No air can be recirculated because of the potential

potential for recirculating contaminants from the laboratories. This results in significant energy usage due to the increase in cooling and heating of the air from the outside air conditions.

"In a regular building, about 80 percent of the air is recirculated," Monte said. "In a laboratory with a fume hood, air going through becomes contaminated and cannot be recirculated. We're constantly heating or cooling new air coming in. So, the energy cost is much, much more."

The team put in a system that would give research scientists 100 percent of the air they needed when they opened a fume hood door, Monte said. "But we took it a step further, designing a system that would tell us when the fume hood would be open. This would give us better energy efficiency by not using the air unless the fume hood was in use."

Before the construction of Buildings 6 and 7, all of Boehringer Ingelheim's facilities utilized constant volume bypass type fume hoods. This type of fume hood has a continuous exhaust rate of 1400 cfm each, independent of fume hood sash position.

In Buildings 6 and 7, variable air volume type fume hoods were utilized. These fume hoods are equipped with combination horizontal sliding and vertical rising sashes and variable air volume, constant face velocity, control devices. The combination sashes allow the user to adjust the open portion of the fume hood face to the minimum area required to accommodate the scientists' activities. The fume hood face velocity controller, monitors the positions of the fume hood vertical and horizontal sashes, calculates the open sash area and the required airflow, to maintain 100 fpm velocity through the open sash area. The controller then modulates the fume hood exhaust air valve to achieve the calculated air flow. These controls throttle exhaust air flows in the range of 250 cfm, minimum airflow with the sashes closed, to 1400 cfm maximum with the vertical rising sash open 18 inches.

"In very general terms, we used the variable air volume (VAV) control strategies to give the fume hood air only when it was need," Monte explained. "The VAV system senses how much the sash of the fume hood is pushed up, calculating the space that is open and how much air has to flow through that space. The sensors inside the fume hoods calculates this immediately."

LAB AIRFLOW CONTROL

In addition to the economic advantages of airflow control, the installed controls also maintain the laboratory space pressurization. Laboratory airflow control is accomplished by tracking the fume hood exhaust and general exhaust, and providing the appropriate supply air flow rates to achieve the desired room pressurization relative to adjacent spaces. Generally, the controls assure that more air is exhausted from the lab than supplied, to assure that transfer air from adjacent spaces is into the lab rather than out of the lab.

This was all part of the first phase, according to Monte. A proximity sensor is currently being installed in the fume hoods of Building 6, successfully completing the project. The proximity sensors can determine if a user is standing in front of a fume hood. When the user has walked away from the fume hood, no longer using it, the air flow is automatically lowered and an approaching person causes the flow to increase to safe levels. This control system will increase energy savings, since the present system runs at the high flow rate when a scientist forgets to close the sash.

MECHANICAL SYSTEMS FLEXIBILITY

It is important that the research and development facility be sufficiently flexible to allow remodeling with minimal expense. Air balancing of a laboratory facility is an expensive, but very important process, as the air balance is largely responsible for containment of contaminants in the laboratories. Remodeling often introduces changes in the air flow requirements within the remodeling spaces. These changes in air flow in the remodeled space can significantly change the air balance of each of the other spaces served by the system. The air handling systems and exhaust air systems, serving Buildings 6 and 7 are designed to provide flexibility to allow the laboratories to be remodeled, as needed to meet changing demands, without affecting the air balance within adjacent laboratories. This minimizes the cost of rebalancing air systems after remodeling is completed.

The supply and exhaust air terminals at each laboratory have pressure independent controls. That is, they are capable of maintaining the required airflow, to the associated space, even with fluctuating pressures in the distribution duct systems. These same controls also provide for stable room air balance as supply and exhaust flows in adjacent laboratories change in response to fume hood use.

SAVINGS

The use of variable frequency drives allows the system to run at lower than constant volume speeds. Total cost savings are attributed to the cost of conditioning air.

"We were able to operate, using only the amount of air that was needed to condition the building and protect the scientists working in front of fume hoods as opposed to providing the maximum amount of air at all times in the old buildings," Monte said.

By reducing the amount of air needed in Buildings 6 and 7, Boehringer is saving $160,635 per year. In addition, by installing the VAV systems, the company received a $159,700 rebate from its local utility.

In addition to receiving the 1996 FAME Award of Excellence, Boehringer has also received the 1996 Energy Conservation Award from Northeast Utilities in Connecticut.