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JANUARY 2001

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Eliminating Containment & Re-entrainment Problems for Hydrocarbon Research

Indoor air quality and hydrocarbon processing research

A case study on eliminating containment and re-entrainment of laboratory workstation fume-hood exhaust

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Fig. 1. Ashland's research complex, Dublin, Ohio.

Indoor air quality (IAQ) has become a popular subject in the HPI over the past few years, especially in laboratory environments where research is conducted at workstations that generate toxic and odoriferous atmospheric fumes. While expanding their Technical Center East facility at the companies' headquarters in Dublin, Ohio, Ashland Specialty Chemical Co. and Ashland Distribution Co. have examined the IAQ issue. Many ventilation/exhaust options for workstations during the planning phase were incorporated and evaluated. As a result, benefits included maximizing employee protection, preventing exhaust re-entrainment, eliminating odoriferous exhaust, and lowering maintenance and energy costs for laboratory-workstation fume-hood exhaust systems.

Ashland's new Technical Center East building, dedicated in October 1998, represented the first major expansion of the technical facility since the early 1970s, when the two companies (then known as Ashland Chemical Co.) established their headquarters in Dublin. The new building, with a total of 115,000 sq ft, is mainly dedicated to customer support, product development and research for the composites market. There are about 100 dedicated laboratory workstations in the facility, with technologically advanced exhaust fume hoods and controllers that automatically manage airflow, reducing it when the workstations are not being used. A built-in alarm system provides warnings if airflow problems occur. This design also helps conserve energy and enhance employee health and safety factors.

Ashland's technical center—with its two connected buildings—(the original Technical Center West and the expanded Technical Center East)—encompasses 358,000 sq ft overall, housing about 250 scientists, engineers, technicians and support personnel. The research and commercial development activities there are primarily geared towards Ashland's specialty chemicals businesses—focusing on composites, adhesives, foundry products (metal casting) and electronic chemicals.

Public attention is focused on IAQ. Recent litigation against some international oil companies, FORTUNE 500 industrial firms, and even a nationally known university hospital with regard to IAQ and employee health problems, has focused public attention on this issue. In fact, a full-page story in USA TODAY described seven laboratory researchers at a major oil company's research facility who died as a result of contracting glioma, a form of brain cancer, allegedly as a result of workplace conditions associated with laboratory workstation exhaust. While this case has been in the courts for more than 10 years, the newspaper reported that the numbers (of tumors) "represent a far larger number of cancers—*eight times greater*—than would normally be expected among the approximately 500 people who have worked in the same building complex since it opened in 1970."

That finding prompted additional statistical analyses to back up the claim that these researchers represented an unusually high number of cancer victims in one location. Litigation in this case is centered on "unsafe levels of chemicals by badly designed exhaust hoods and ventilation systems," according to *USA TODAY*. Wind tunnel model tests that concluded exhaust gases "expelled from the building were somehow being sucked back in" were considered "unfounded." However,

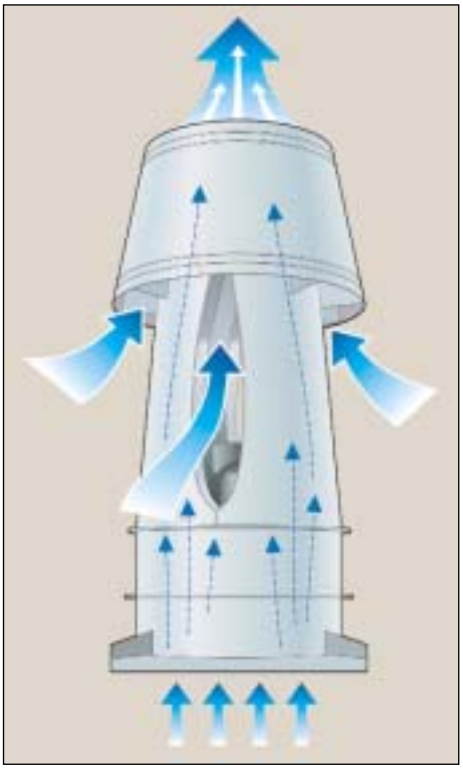

Fig. 2. Airflow activity model.

one of the company's retired researchers noted "significant problems" that would cause the ventilation system to function improperly, and the company ultimately replaced the ventilation systems in several buildings.

Laboratory exhaust containment and re-entrainment can be serious issues. Since many petrochemical firms conduct research at laboratory workstations that generate exhaust effluents, this problem must be—and, for the most part, is—taken seriously There are two basic causes of harmful exhaust that can lead to health problems in the laboratory. First, if it is not removed sufficiently at the fume hood, laboratory workstation exhaust can remain in the room; this is commonly known as "containment." Workstation fume-hood exhaust from the building roof, on the other hand, can also re-enter the building or adjacent buildings; this is referred to as "re-entrainment." (Re-entrainment can be caused by many factors, such as inefficient roof exhaust fans, poor exhaust stack design and/or location, position of building air intakes, weather and wind conditions, and other factors that must be considered when designing a laboratory workstation fume-hood exhaust system.)

Implications of roof exhaust re-entrainment. While roof exhaust re-entrainment can be a serious problem, all of its negative implications may not be widely known. In fact, not only can the health of building workers be affected by exhaust re-entering the building through windows, vents, air intakes and door openings (among other possibilities)—but the legal consequences can extend well beyond their employers. For example, there have been cases where building owners consulting engineers and heating, ventilation and air-conditioning (HVAC) contractors, even architects, were named as defendants in major cases associated with employee illness and IAQ.

Fig. 3. TS series mixed-flow impeller fans connected to laboratory workstation fume hoods.

As a certified industrial hygenist as well as a certified facility manager, Mr. Mike Cornett serves as the facility manager at Ashland's Dublin research complex. Mr. Cornett was aware of the potential problems associated with laboratory workstation fume-hood exhaust containment and roof exhaust re-entrainment, and sought an effective fume-hood exhaust system to protect employees. He began by evaluating the existing laboratory fume-hood exhaust system at the company's Technical Center West building. That system—which had been in use for many years—consisted of one dedicated exhaust fan and one roof exhaust stack for each laboratory workstation fume hood.

Mixed flow impeller-type systems. Newer-technology now offers more attractive alternatives to that type of maintenance-intensive, inefficient and unsightly approach to laboratory workstation fume-hood exhaust. One option involves use of mixed-flow, impeller-type laboratory fume-hood exhaust fans. These fans typically send the exhaust stream hundreds of feet into the air in a powerful vertical plume—mixing outside air with exhaust gases (dilution) to prevent re-entrainment and eliminate odor problems in the neighborhood. They also provide other advantages, such as variable air-volume control for enhanced operating efficiencies and lower energy costs while helping to heat and cool laboratory rooms.

While planning the new roof exhaust system for the Technical Center East's laboratory building, Mr. Cornett set certain performance criteria, such as heat recovery for added efficiency and lower energy costs; variable volume, laboratory fume hood airflow control for enhanced performance; and minimum maintenance for roof exhaust systems. To enhance safety, Ashland also sought roof-exhaust fans with constant speed and direct drive motors to provide variable volume airflow control, while maintaining the highest possible exhaust-stack exit velocity.

Mr. Cornett met with Mr. Lance

Bowman at Precision Air Co., Delaware, Ohio, who introduced him to a mixed-flow, impeller laboratory workstation fume-hood exhaust system. Mr. Bowman explained that these systems have been in use for nearly two decades, at research facilities at universities, hospitals and petrochemical and other industrial process organizations—with excellent success.

Employee health and safety came first. Ashland management considered its first priority to be the health and safety of the buildings' occupants. "After that is done, we also wanted the most efficient, most reliable and lowest maintenance system we could find," Mr. Cornett added. By eliminating the need for periodic maintenance for its exhaust fans, Ashland maintenance staff would not be exposed to possible harmful exhaust on the roof as well as other dangers associated with working on the rooftop. In that way Ashland maintenance people could be used more productively elsewhere at the facility. To eliminate possible containment problems, the system would also have to provide an effective velocity at the face of the workstation fume hood. While that was important, discharge velocity of the fans (on the roof) was still the main consideration, since that capability would eliminate possibilities of exhaust re-entrainment.

It is now over two years since the system on the newly constructed Technical Center East building was installed. It has performed to everyone's expectations without problems. There has been positive feedback from building occupants and Ashland managers on the laboratory workstation-exhaust control system in its entirety. The system consists of five low-profile TS series mixed-flow impeller 25,000-cfm fans connected to the entire laboratory workstation fume hoods through ductwork into a common manifold. The manifold is connected to ductwork running vertically along the side of the building and extending into a plenum on each side of the roof. On the roof ductwork radiates into the center where the fans are mounted.

Maintaining a good-neighbor policy. Mr. Bowman commented that Ashland is a good-community neighbor, making certain that its research laboratory workstation fume-hood exhaust was efficiently diluted when it was removed from the building. Ashland wanted a system that required minimal maintenance since it does not have a large maintenance staff, and it also desired a system that fits into the architectural scheme of its building with regard to the low-profile design of the exhaust fans vs. 25-ft or 30-ft-tall stacks. In its research facility's other building (Technical Center West), now being refurbished, Ashland plans to replace 200 individual exhaust fans with a single, TS mixed-flow impeller exhaust system. ■

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