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Figure 1 *The Strobic Air Tri-Stack system (surrounded here by individual centrifugal fan exhaust stacks from individual fumehoods) handles exhaust from 16 laboratory fumehoods through a common plenum on the roof.*

Eliminating fumehood exhaust reentrainment problems

When officials at the University of Ottawa (Canada) discovered a ventilation flow rate balancing problem in Vachon Hall, the school's Biochemistry Center, they were faced with a dilemma. Some of the center's laboratory fumehoods were being exhausted at higher volumes than required, occasionally disrupting work flow. Second, the fumehood exhaust would, in some conditions, reenter the building, mainly as a result of high winds, since some of the exhaust fans and ducts were too close to ventilation intakes to prevent reentrainment.

To solve these problems, the university's facilities management staff decided to retrofit the building's exhaust and main air handling systems. However, a new six-story building was to be erected adjacent to Vachon Hall, and several older roof exhaust fans on other buildings had to be moved to comply with Ministry of the Environment regulations. These 15 individual fans, some 20 years old, were not properly positioned to function as discharge points for the laboratory fumehoods. A vertical discharge stack was considered for the roof, but some existing fans would not be compatible with regard to necessary air quantity and static pressure requirements.

Alternatives considered

Herb Dean, Senior Engineer in Physical Resources Services at the university, planned to purchase several smaller fans to replace the older ones. However, because costs for new fans and construction were greater than anticipated,

another solution was needed. Dean met with Fred Belusa (Belnor Engineering, Inc., North York, Ontario, Canada), who was installing variable speed drives for fumehood control at the university's new chemistry building.

Belusa told Dean about Strobic Air Tri-Stacks® (Strobic Air Corp., Harleysville, PA, *Figure I*) laboratory fumehood exhaust systems, which eliminate reentrainment by mixing outside air with plenum exhaust and provide highly effective plume dispersion capabilities. Other important advantages included direct drive, sealed bearing motors that are virtually maintenance free; lower energy consumption; lower installation costs than centrifugal fans; and quiet operation.

Principle of operation

The system blends outside air with exhaust air to effectively dilute laboratory fume exhaust, and performs as though a 60-65 ft high stack were in place. It also performs better than the smaller individual centrifugal fans with respect to plume dispersion. This lowers capital equipment costs, operating costs, and maintenance costs. As a typical example of energy savings and performance efficiency, a 10,000 cfm system would have a total flow of 65,000 cfm in a 15 mph wind at an equivalent stack height of 30 ft, with just a 7-1/2 hp motor. This translates into free dilution of 550%. This process helps to dilute the exhaust air from the fumehoods prior to its release into the atmosphere, thus effectively eliminating pollution problems with extremely high efficiency.

To help lower horsepower requirements and thus conserve energy, the systems incorporate a straight through patented venturi teardrop design to enhance efficiency. The wind band (the conical shape of the lop of the system) entrains outside air above the motor to enhance discharge volume and effective stack height. Tri-Stack systems conform to ANSI/AIHA Z9.5, ASHRAE 110, and NFPA 45 standards, and are UL listed.

System configuration

It was determined that the Vachon Hall configuration required exhaust discharge points for 16 laboratory fumehoods, each with a volume range of between 800 and 1000 cfm per hood, depending on size and use. Since half of the fans would not have been suitable for the retrofit project due to their size, capacity or configuration, instead of buying several small fans, one Tri-Stack was installed.

A common plenum on the roof was used to tie in existing exhaust duct work, thus eliminating the problems associated with the original 15 fans on the roof. With the Strobic Air Tri-Stack, there are no belts, pulleys, motor bearings, flexes, or spring vibration isolators to install and maintain. The university saves money on energy and operating costs, and there is no need for replacement parts or hazardous maintenance procedures on the roof in inclement weather.

Energy consumption

With its record of success, it was decided that the exhaust system would serve equally well as an application in the planned retrofitting of another campus science building, Marion Hall, which houses the university's undergraduate laboratory for all first year science/engineering students. With about 200 students on the top floor laboratory at any one time, a total of 27 fumehoods had to be in operation. Since the laboratory is also used for smaller, advanced class research for 75-100 students at a time, there are fewer workstations in use at any given time. Dean saw that another Tri-Stack installation here could meet his need to safely exhaust only those fumehoods being used.

Working closely with Belnor, he had three Tri-Stack systems installed to provide constant full-volume plume dispersion for all 27 fumehoods and prevent reentrainment here also. The system now provides three stages of control to minimize energy consumption when only some of the fumehoods are in operation. A third of the laboratory can be cordoned off and one Tri-Stack can be started; if another is needed, it can be started to handle another 10 workstations. This substantially reduced costs over installing individual fans with high exhaust stacks on the roof for these laboratories since they are all used together anyway.

Another Tri-Stack system was installed in Marion Hall's junior and senior year advanced class laboratory to accommodate six additional laboratory fumehoods there. Once again, this single system provided the proper exhaust levels and is now the fifth in operation at the university. Since the installation of the first Tri-Stack system in Vachon Hall, all of them have performed flawlessly, without any maintenance problems.

The systems eliminate expensive, space-consuming and maintenance-intensive individual roof-mounted fans and stacks. The Tri-Stack system eliminated the need to install a dozen fans on Vachon Hall and approximately 30 fans on Marion Hall to complement the existing stacks and fans there.

The system also eliminated the considerable expense involved in attaching tall stack guy wires and mounting hardware to the roof, with the casing, drains, power lines, wiring, disconnect switches and controls needed for a stainless steel vertical discharge stack approximately 20 ft high. There are also the advantages of both a lower roof profile and space requirements that do not interfere with a building's overall aesthetics.

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