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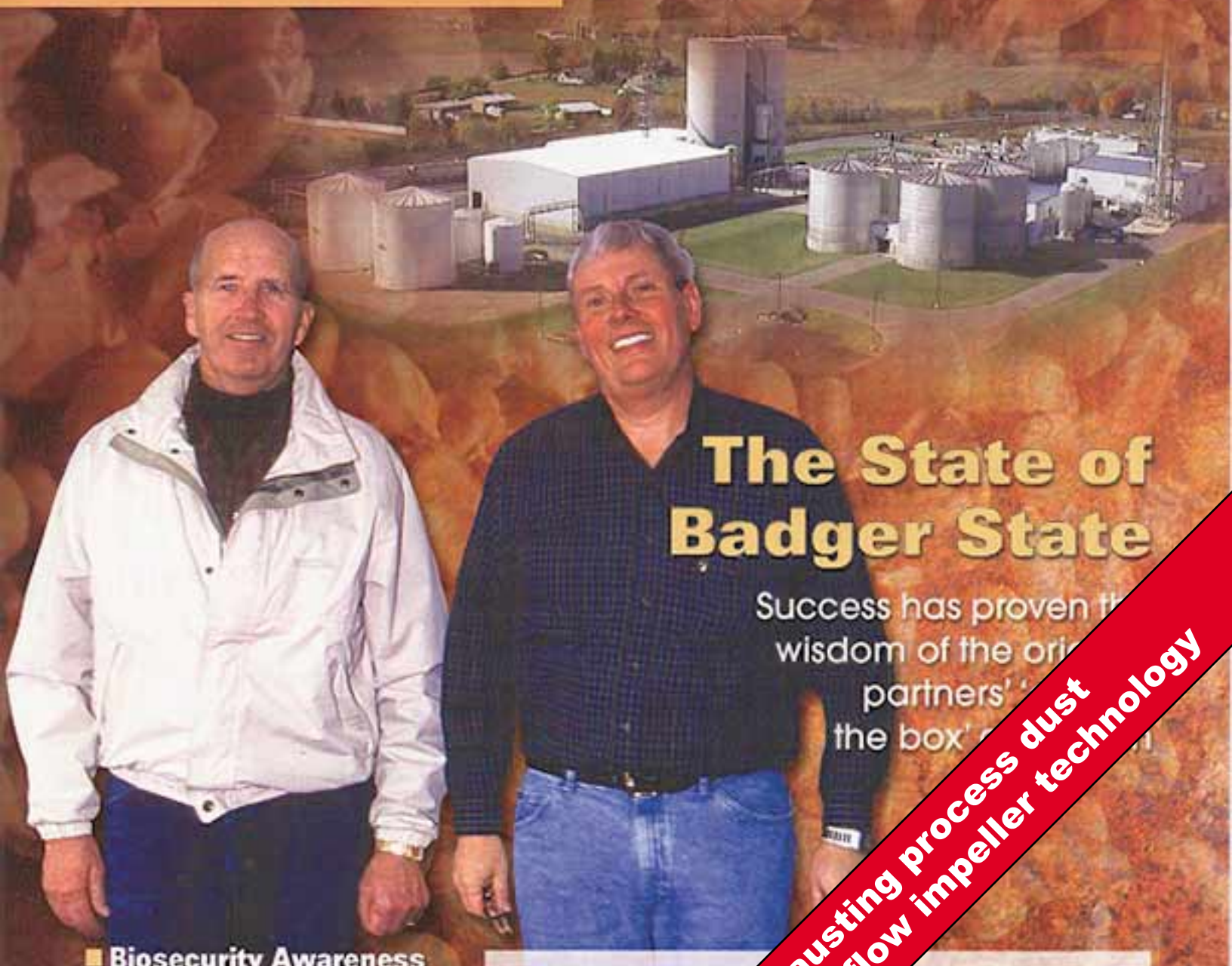

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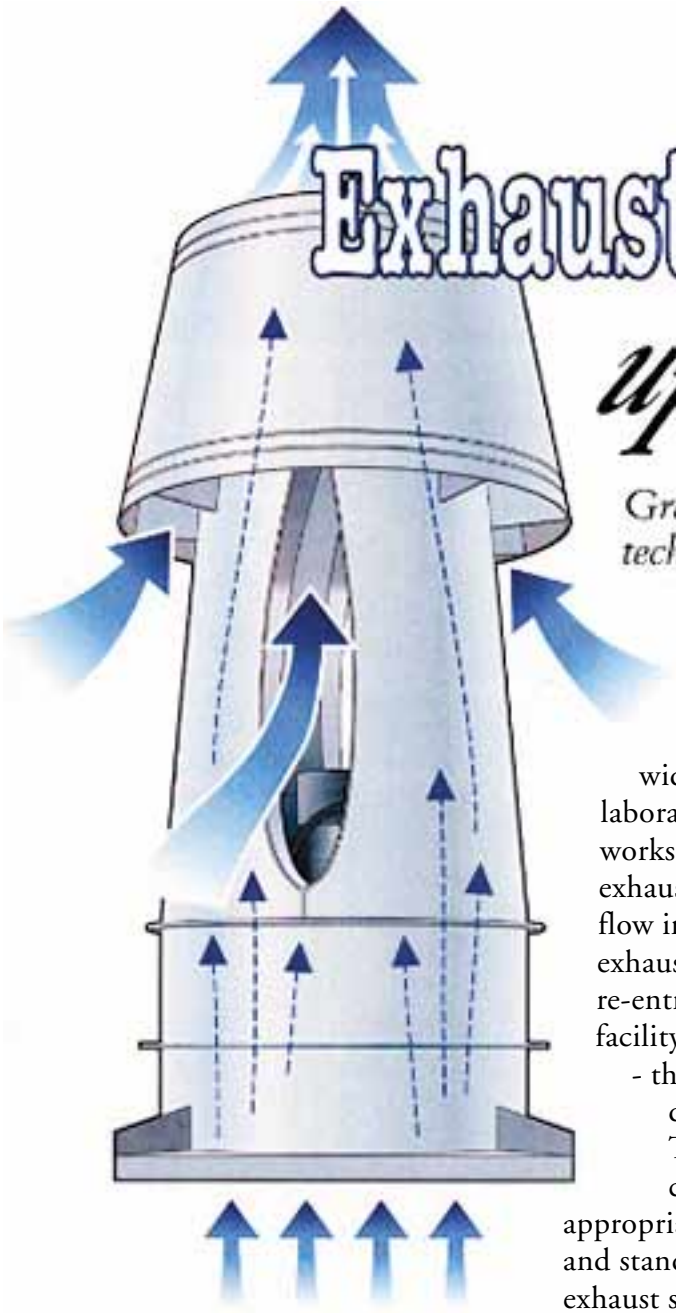
Exhausting process dust with mixed flow impeller technology



Exhausting process dust up, up, and away

Grain Processing Corp. uses mixed flow impeller technology to manage process dust — and laboratory workstation fume hood exhaust

By Paul A. Tetley

While the "confine, seal, suppress" approach to dust control (FEED &GRAIN, February/March 2003) is suitable for many dust control applications, there are new approaches available depending upon the nature of the dust problem. One which has been gaining popularity in the past few decades is mixed flow impeller technology.

This technology, applied to roof exhaust systems, is widely used at research laboratories to handle workstation fume hood exhaust emissions. Mixed flow impeller technology roof exhaust fans prevent exhaust re-entrainment into the facility - or adjacent buildings - through air intakes, vents, doors and windows. These systems also aid compliance with appropriate air pollution codes and standards since they send an exhaust stream upward in a vertical plume (similar to a jet engine exhaust) while mixing the exhaust stream with outside, ambient air to effectively dilute pollutants. The combination of a powerful vertical jet flow with the diluted exhaust stream thus permits compliance with appropriate air quality standards.

Mixed flow impeller technology at work

These advantages have helped increase the popularity of mixed flow impeller technology systems at laboratories of all kinds including at universities, hospitals, pharmaceutical organizations, and chemical/petrochemical companies, among others. Feed and grain processors also use these systems in their laboratories (for workstation exhaust management) and in their process areas to control dust.

At Grain Processing Corp. (GPC), Muscatine, IA, one of the country's largest wet corn millers, mixed flow impeller fans are used both at the company's laboratory research workstations and in the production areas to manage ambient process dust.

GPC processes corn into grain alcohol, grain neutral spirits, and other byproducts such as cornstarch, corn oil, corn germ, corn hulls, and other products that are used in animal feeds and marketed by a sister company (Kent Feeds Inc.). GPC also produces corn sweetener from cornstarch, marketing it under the popular name Maltodextrin. Ethanol produced by GPC is used for supplementing fossil

fuels, as well as in beverages, pharmaceuticals and cosmetics. Its grain alcohols are considered "highest grade pharmaceutical alcohols and beverage alcohols," and starch products from GPC are sold to the paper processing and pharmaceutical markets.

Preventing exhaust re-entrainment

In the course of its work GPC operates advanced laboratory research facilities that use such hazardous chemicals as ethylene oxide, propylene oxide and acrylonitrile, among others. To help assure worker safety and prevent re-entrainment of laboratory workstation exhaust fumes into the building - and comply with applicable air pollution codes and standards - Dan Freeman, the project manager for design and construction of the company's newest research facility, specified mixed flow impeller systems for exhausting the company's laboratory as well as its 20 laboratory workstation fume hoods. The laboratory area is a closed loop facility, requiring 100% makeup air.

The laboratories at GPC comprise about 10,000 square feet; the processing and production area contains about 100,000 square feet. Fourteen roof-mounted mixed flow impeller fans provide ventilation for "an assortment of process areas that include food grade materials, biofermentation, and dusty and hazardous environments," Freeman explains. "One of the key issues with regard to mixed flow impeller technology was the systems' ability to send the discharge air in a strong vertical plume high enough above the building where it is dispersed into the atmosphere, by a combination of dilution and wind."

The company had been using traditional belt-driven centrifugal fans on its roof with individually dedicated, tall exhaust stacks, Freeman points out. "Some of the concerns with these fans included routine, weekly bearing and drive belt inspection, and drive belt replacement, perhaps as frequently as every six months depending upon atmospheric conditions on the roof." The replacement mixed flow impeller systems use direct drive, sealed bearing motors. The systems have been in operation for 7 years and the company has had zero problems with them.

No tall stack headaches

GPC's first floor contains eight laboratory workstations and fume hoods with 12 on the second floor; the fume hoods are manifolded together into two mixed flow impeller fans mounted on the roof. Roofline aesthetics were also a consideration for changing to mixed flow impeller technology according to Freeman. "We put a panel of people together from all walks of responsibilities here at GPC, accountants, engineers, laboratory people, and so on. We showed them an exterior view of the mixed flow impeller fans installed in other facilities, then asked what they thought. Their response was generally the same—always favorable," he adds.

Obviously the lowest possible roofline profile not only eliminates the "smoke stack" look and negative connotations perceived by many people, but may actually be required (in some jurisdictions) to conform to applicable ordinances.

Mixed flow impeller fans for process exhaust

Greg Gordy-Anson, the project manager for GPC's Pilot Development Facility at the Research and Development Department, was also involved in design and specification of the HVAC systems and laboratory workstation fume hood exhaust systems. He is responsible for all of the buildings' systems, and is also the project manager for pilot development, supervising many different projects.

Feed and grain processors also use these systems in their laboratories and in their process areas to control dust.

Anson points out the mixed flow impeller systems are employed in a number of process areas for the company's pilot group, which includes several different processing areas. These are generally segmented by types of materials being employed such as solvents or dry chemicals and raw materials. Each area is equipped for different purposes and operates under different classifications depending upon jurisdiction by OSHA, National Electrical Code, etc.

"Basically, we have five different areas, with two of them grouped together on one set of mixed flow impeller fans and two that have their own dedicated mixed flow impeller exhaust and supply systems," he adds.

Eliminate virtually all maintenance issues

Mixed flow impeller systems are designed to operate continuously for years with minimal maintenance. Their direct drive motors have bearing lifetimes of L_{10} 400,000 hours.

These systems are also virtually maintenance-free; unlike centrifugal-type fans there are no belts, elbows, flex connectors or spring vibration isolators to maintain.

In most cases centrifugal-type fans are mounted on rooftops, fully exposed to the elements. Consequently, for maintenance purposes many users construct "penthouses" to enclose these fans for weather protection, and to protect their maintenance workers from the elements. Penthouses can be very expensive ($50,000 is not an unreasonable construction estimate). Mainly, however, working inside a penthouse can subject maintenance personnel to exposure to noxious and/or toxic fumes while adjusting or changing motor drive belt.

With any roof top exhaust fan, vibration also becomes a consideration. Here, mixed flow impeller fans offer substantial advantages over conventional centrifugal fans. Vibration is divided into two components: radial and axial. Because the radial vibration characteristics of mixed flow impellers parallel the building's roofline, there is a substantially lower axial component of vibration forced vertically onto the roof.

Low operating costs help the bottom line

Mixed flow impeller fans generally consume about 25% less energy than conventional centrifugal fans, and offer faster payback periods as well. Typical energy reduction is $0.44/cubic foot per minute (CFM) at $0.10/kilowatt-hour, providing an approximate two-year return on investment in many installations.

Ambient heat recovery saves thousands

When an enclosed work space (such as the GPC research laboratories) requires 100% conditioned makeup air, savings in the thousands or even hundreds of thousands of dollars a year may also be achieved with mixed flow impeller fans by recovering ambient heat or cooled air from workstation fume hood exhaust before it is dispersed into the atmosphere.

By using heat recovery coils filled with a solution of glycol and water, heat or cooling energy is removed before workstation exhaust (along with ambient temperature room air) is discharged into the atmosphere. This "conditioned" air is added to the makeup air brought into the building's intake ventilation system. For each 1 degree F of heat added to makeup air by this method, energy costs are lowered about 3%. For colder climates, annual heating energy cost reductions of 30% or more are not usual.

Costs for 100% conditioned makeup air can be very high, in many laboratory environments exceeding $4/square foot/year. Since energy costs represent a substantial part of a laboratory's operating budget, it makes sense to investigate the potential savings for both new construction and retrofitting.

Pollution controls

Scores of pollution control standards must be addressed with regard to dust and/or other exhaust emissions at feed and grain processing facilities; mixed flow impeller technology may not be the ideal solution for some applications. But, this technology is being used successfully in a broad cross-section of industries.

Thousands of these systems have been installed over the past few decades to prevent re-entrainment, control odors, and comply with pollution control standards and guidelines from the Occupational Safety and Health Act and regulations from the Environmental Protection Agency. In addition to these major requirements, there are also ventilation standards of American National Standards Institute, American Industrial Hygiene Association, American Society for Heating, Refrigeration, and Air Conditioning Engineers, National Fire Prevention Association, and others.

While planning a new facility, or retrofitting an existing one, mixed flow impeller technology offers an attractive approach, worth further investigation.

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