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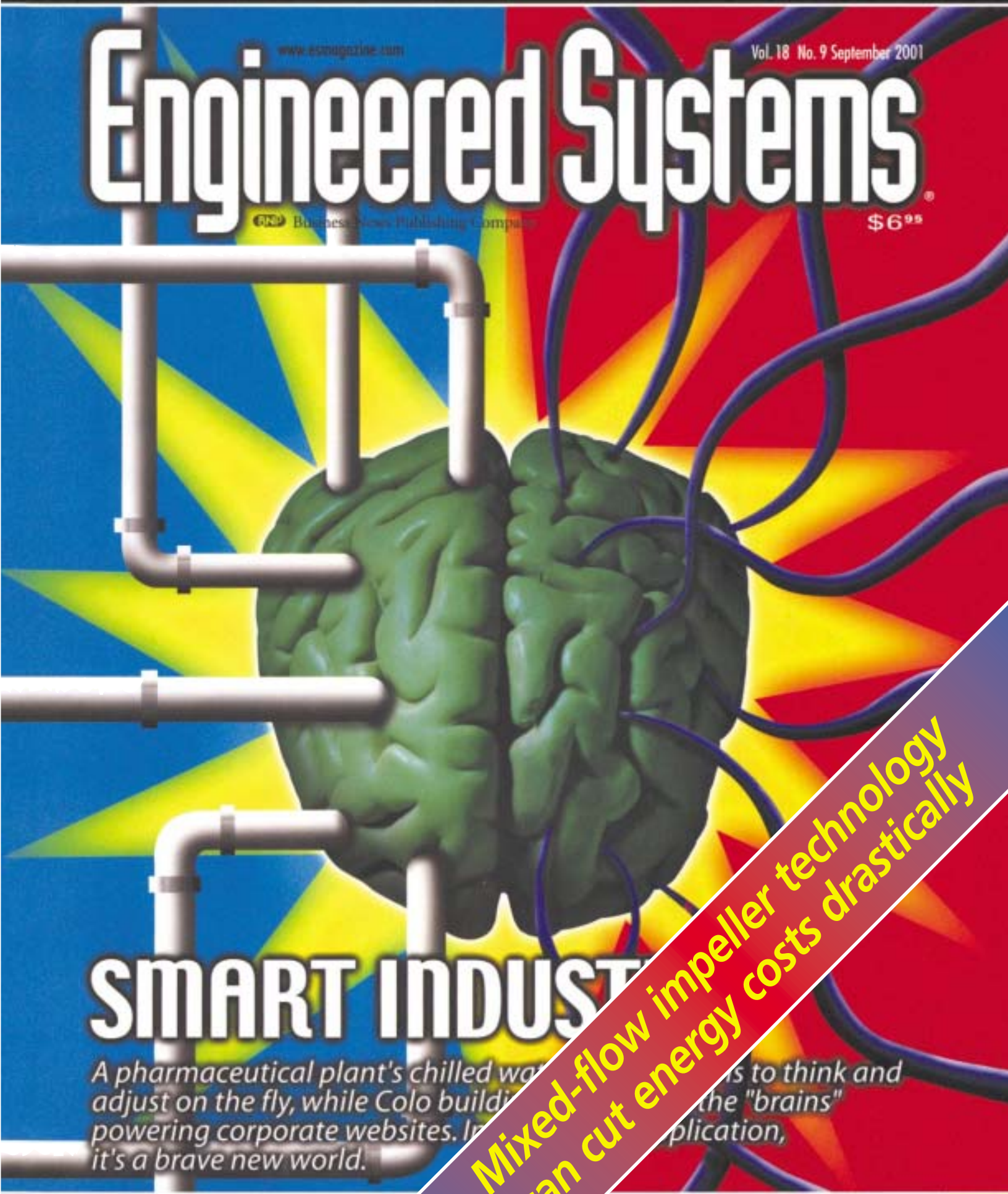

SMART INDUST

A pharmaceutical plant's chilled wa ...s to think and adjust on the fly, while Colo buildi ...the "brains" powering corporate websites. In ...plication, it's a brave new world.

Mixed-flow impeller technology can cut energy costs drastically

NEW DISCOVERY FOR HEAT RECOVERY

Mixed-flow impeller roof exhaust technology usually has been deployed for re-entrainment prevention and odor control. Now, it's providing energy savings in industrial and educational settings in a heat recovery role.

BY PAUL A. TETLEY

Many facilities that require 100% makeup air for workstation or production environments (typically at research laboratories, pharmaceutical processing plants, and for cleanrooms and isolation rooms) are burdened with extraordinarily high energy costs for heating and cooling. In some cases, it isn't unusual to see annual costs of up to $4/cu ft solely for conditioning makeup air. Since energy costs represent a substantial part of an organization's operating budget — and since they are rising substantially (probably more than 50% this year over last) — it is prudent for contractors, facility managers, and building owners to seek out new approaches to reduce these costs.

One relatively new solution to this problem is to use existing roof exhaust fans that remove ventilation and/or process air from the building. Since this air (and any pollutants) cannot be brought back into the building, valuable heating (or cooling) energy is also being exhausted into the atmosphere.

Mixed-flow impeller roof exhaust systems have begun to offer an alternative to losing this energy via exhaust. Through the use of unique heat recovery modules, this warm (or cool) air is removed prior to its discharge into the atmosphere, and transferred back into the building's intake ventilation system. As an example of its efficacy, consider that for each 1°F of heat added to makeup air, energy costs are reduced about 3% with this method; and it is not unusual to see heating energy cost reductions of 30% or more. Similar savings — although not quite as dramatic — may also be realized for cooling.

This year, major energy users are paying out thousands or even hundreds of thousands of extra dollars for heating and cooling costs. These costs are increased substantially when building intake air must be continually renewed (conditioned) vs. recirculated to comply with health and safety requirements. Obviously, it costs money to heat or cool this makeup air, and the more heat that can be recovered from building or process exhaust and returned into the intake or "makeup" side of the hvac system, the lower overall costs will be.

PREVENTING RE-ENTRAINMENT AT INDIANA WESLEYAN

Universities that operate teaching and research laboratories are among the more particularly sensitive organizations with regard to keeping a keen eye on operating costs. Facilities managers at Indiana Wesleyan University were concerned with costs as they worked on a 10-year program to construct a number of buildings. Terry Wagner, P.E. of Design Collaborative (Fort Wayne, IN) joined the project in 1992, contributing to a new hvac system for a performing arts center.

More recently, when the need arose for a new laboratory facility, the facilities managers again asked Wagner to participate. This facility occupies about 71,000 sq ft. According to Wagner, the original facility contained about 28,600 sq ft, and the expansion added 42,300 sq ft. Since the original building was stripped completely, all services were removed and new, updated systems installed.

The first floor was devoted to classroom areas, lecture rooms, and offices, while laboratories occupied the second and third floors. On the third floor, there were six classroom laboratories and three research laboratories involved with research in organic chemistry, biochemistry, and analytical chemistry, as well as three other research laboratories. Also in the facility were four classroom laboratories and a research laboratory involved in all phases of biology from beginning through advanced and microbiology. There are nine laboratory workstations on the second

floor and 21 on the third floor.

Wagner said that while there were no specific codes in the state of Indiana with regard to laboratory workstation fume hood exhaust, he worked closely with Robert Getts at Controlled Environmental Systems, a sales representative organization specializing in laboratory workstation fume hood exhaust systems. Getts reviewed accepted practices with Wagner and the system was configured based on these standards and subsequently presented to university management for review and approval. One of the critical issues at the university was prevention of exhaust re-entrainment as well as elimination of odors on campus. Wagner pointed out that in the original laboratory facilities, dedicated centrifugal fans were used for each laboratory fume hood, and there was no provision for controlled makeup air with this system with the exception of "normal" outside air intake at the central air handler.

HEAT RECOVERY: DOING THE MATH

Once the issue of re-entrainment was resolved, heat recovery became a major subject, and Wagner calculated projected yearly cost savings from using the mixed-flow roof exhaust system. As he said, "The two major considerations are obviously the energy savings and the operating cost penalties." Wagner is referring to a unique heat recovery module (essentially a heat exchanger containing coils filled with a solution of glycol and water) that extracts ambient air from the laboratory workstation fume hood exhaust stream before it is discharged above the roofline. This warmed air is transferred to the intake or makeup side of the building's ventilation system, and reintroduced as part of the conditioned air entering the building. As a result, the amount of natural gas to preheat the makeup air is reduced substantially. The heat recovery modules are designed to work with mixed-flow impeller exhaust systems as a complete package.

With regard to the cost penalties, Wagner commented that, "Each one of the heat recovery coils has a static pressure penalty for exhaust and makeup air-handler fans. On this particular facility, we have two makeup air handlers and two mixed-flow impeller laboratory workstation exhaust systems (one system for each floor).

"On each one of the makeup air handlers, an additional 0.5 in. of static is required so you relate that out to a constant 3 boiler horsepower (bhp) penalty because the extra heat recovery coil is in place. The exhausters each have a similar penalty except they have 0.8 in. additional static which relates to 5.3 bhp." Wagner added that the same rule applied on the pumping horsepower to move the glycol around the loop. Power penalties on these pumps were about 5 bhp for both floors. "So you add all that up and it ends up in a dollars per hour calculation. Relating it to an average $0.08 kWh average, it adds up to about $1.64/hr to run the extra penalty," he commented.

On the savings side, in the summer there are about 30 tons of air conditioning being saved on both the systems. "Ours was an air cooled system which is about 1.3 kW/ton. If you average this all out, there is a savings of about $3.15/hr based on the same $0.08 kW cost. The difference is about $2/hour savings in the summer. If you calculate the number of hours of operation, there is about $9,100 for savings in the summer. If you do the same for winter, you average about 959 MBtuh of constant savings and that ends up to be about $7.67/hr savings. So again, pull out the $1.06 on the penalty and you end up saving about $6.61/hr. Relate that out to hours and it's about $28,900 a year savings, and the total of the two ends up being about $38,000 a year savings on energy; that includes the penalty because of the extra static on those air handlers and pumps. Not a bad return since the total additional cost for the recovery system was $52,000, which included controls according to the mechanical contractor, Brad Jenkins," Wagner concluded.

With regard to roofline aesthetics, Wagner commented that he was not aware of any requirement in the state code. His concern for the installation was based on what he calls "Good design practice ... Our architects spend all of their effort to make the form work for them and we have to make the function work, but aesthetically if you have this big stack sticking off the top of the roof, they would probably gawk at that and say it was not acceptable." The mixed-flow impeller system offers a low profile and is not objectionable, Wagner said. "You can see it a little bit away from the building but obviously less than if you had tall stacks with guy wires sticking up 50 ft in the air."

PHARMACEUTICAL PRESCRIPTION

Bill Waldron, the facility manager at Neurogen Corp. (Branford, CT) also faced similar problems with regard to high energy costs after completing construction of a new 20,000-sq-ft chemical research building. Neurogen is involved in research and early-stage development of drugs, and occasionally enters into joint ventures for production and marketing of specific drugs with other pharmaceutical organizations. Waldron benchmarks the average cost to condition makeup air in the pharmaceutical research industry at about $3.71/cf/yr. He said this figure is used by most building engineers. On the other hand, total energy costs for his industry can average more than $6/sq ft/yr.

Since code prohibits all air at Neurogen's laboratory workstation environment to be recycled, it must be exhausted. This includes both the ambient air as well as the laboratory workstation fume hood exhaust, considered as "100% exhaust, 100% makeup." The facility is a "constant volume building," which means that the volume of air that enters the building must equal the volume of air that exits it. Faced with the high cost of heating or cooling makeup air, Waldron sought a practical and cost-effective solution. As it turned out, most of the solution was already in place, just above his head.

THE SOLUTION WAS ON THE ROOF

That's because the 18 laboratory workstation fume hoods were being exhausted on the building's roof with mixed-flow impeller exhaust systems. Each system — connected to an exhaust plenum serving the workstations — provides high-efficiency exhaust to eliminate pollution and the possibility of re-entrainment, a particularly critical issue when conditioned air is introduced into a building on a constant flow basis.

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 reentering 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 managers and owners, consulting engineers, hvac contractors, and even architects were named as defendants in major cases associated with employee illness and IAQ.

Neurogen's fume hood exhaust fans use efficient mixed-flow impeller technology to 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 as well as eliminate odor problems. They also provide other advantages, such as low energy consumption and low maintenance requirements.

The mixed-flow impellers at Neurogen also include heat recovery modules. Waldron said that in winter, "There were days when we were putting about 10° into the makeup air simply by treating the air prior to its exit out of the exhaust system and forcing it back into the makeup side." He explained that 10° was the temperature difference between intake air (at outside ambient temperature) and the makeup air after it was passed through the Tri-Stack system's heat exchanger coils. Waldron stated, "For every degree you add, you reduce your energy costs about 3%. A 10° rise in intake air translates into a 30% energy saving. In addition to reducing our costs, we also help contribute to a cleaner environment since less fossil fuel is consumed," he added.

Indiana Wesleyan has achieved an annual savings of approximately $38,000 by deploying its mixed-flow system to aid in heat recovery, while maintaining an aesthetic low profile on campus.

THREE-YEAR R.O.I.

With regard to overall costs — for system hardware as well as energy charges — Waldron believes that a payback cycle of three years or less has made this solution economically sound for Neurogen. (Some users have experienced actual payback in two years or less depending upon system configuration, climate, and other variables.) With energy costs rising dramatically, Waldron believes that Neurogen has taken the right direction with its heat recovery systems on its laboratory fume hood exhaust fans.

Waldron cited some specifics at Neurogen. Since the company is located in the Northeast, it experiences varying temperatures during the year. Conditioned makeup air is either cooled with fume hood exhaust during the cooling season or warmed during the heating season, and the system is only usable when the outside air temperatures are below 40° or above 80°. "You need a big enough difference between outside and inside air to make it practical," Waldron added. With regard to cooling air in warmer temperatures, Waldron pointed out that if outside air at 90° is brought back into the building and sent through the heat recovery system, the air temperature drop is typically 4° to 5° Again he equates these figures to a 3% drop in energy consumption for each 1° drop in air temperature.

ENERGY COSTS WILL INCREASE

When discussing energy costs and the future, Waldron said he expects some "serious increases in electrical power prices in the near future." He added that he has seen no positive benefits to consumers as a result of natural gas deregulation policies on the West Coast. "After salaries, energy is the second-largest expense item in the pharmaceutical research industry," Waldron said. "It is not unusual in a facility such as Neurogen's to use 15% or more of the entire operating budget for energy, and this is not out of line for the industry," he added.

Waldron points out that a key influence concerning capital equipment expenses for energy reduction are the "rebate dollars from the local utilities." He said that, "If you are looking at two projects and one is rebateable and the other is not, all other things being equal, you go after the rebate dollars."

Waldron made it clear that the recent energy deregulation policies in California have not resulted in reducing costs that were anticipated. "In other words, we are not going to deregulate ourselves out of these high energy costs," he added. Consequently, he believes that pharmaceutical companies who are holding up energy conservation programs now because they believe deregulation is "going to do it for them," should perhaps begin looking at other approaches. He commented that "You can tell where the rest of the country is going to be in a year or two by looking at California, and the early results of deregulation there have not been good — in terms of cost and also in terms of reliability of service." He added that he would not "depend on deregulation to cut your energy bills; you have to work on the demand side," he concluded. **ES**

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