Demand Ventilation Control in Commercial Kitchens

"Why didn't we think of this before? What a great application for demand ventilation controls - our kitchen exhaust systems run all day every day, while cooking is intermittent. This control system achieved excellent energy savings while ensuring that the safety and needs of the kitchen staff are continuously met."

Dennis Elliot, Sustainability Manager, Cal Poly San Luis Obispo

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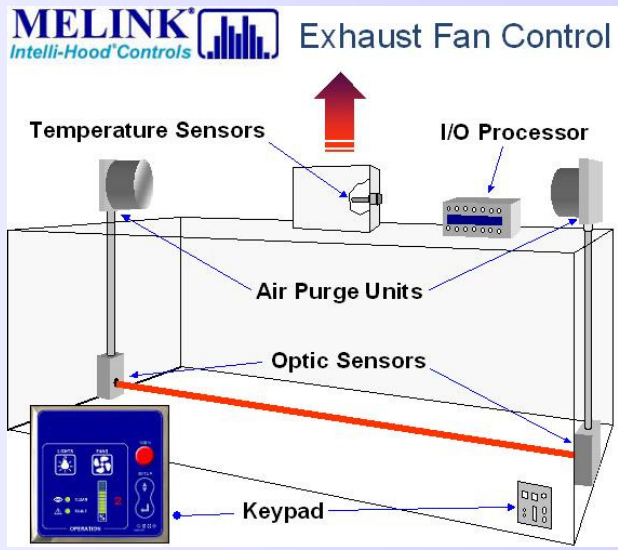
Controls Save Energy for Exhaust Hood Fans and Make-up Air Heating

Most commercial kitchen exhaust hoods operate at 100% capacity all day long, even during idle (non-cooking) periods when ventilation rates can be safely reduced. The cost of wasted energy every year can be thousands of dollars per hood. *An effective way to reduce energy consumption and cost is to control the speed of kitchen ventilation fans based on the demand for ventilation created by cooking.* A properly implemented demand ventilation control (DVC) strategy will minimize the energy burden while maximizing the ability of the hood to capture and contain cooking effluent.

The Melink *Intelli-Hood® Controls* package is a demand-ventilation-based energy management system for commercial kitchen exhaust hoods. Its processor controls the speed of the exhaust and make-up air fans through variable frequency drives (VFDs) based on two types of input signals: from temperature probes placed in the exhaust duct collars, and infrared (IR) beams that cross the bottom of the exhaust hoods. *(Continued on Page 4)*



Product Overview

Energy Savings

- Reduces fan speeds in response to lower cooking loads.
- Typical fan energy reductions range from 40 - 75%.
- Typical make-up air heating and cooling load reductions range from 15 - 40%.

Operation/Maintenance

- Comprehensive programming capabilities with simple operator keypad. Periodic maintenance consists of basic cleaning of optic and temperature sensors.

Manufacturer: Melink Corporation.

Market: Commercial and Institutional Kitchens

Availability: Melink Corp. (http://www.melinkcorp.com)

Public Interest Energy Research ***University of California*** California State University

Field Demonstration

California Polytechnic State University, San Luis Obispo

At **Cal Poly San Luis Obispo,** a single demand ventilation fan speed controller was installed at the kitchen of the main dining facility in the center of the campus This one controller operates three exhaust fans, all serving a large double-island hood. The fans total only 9 horsepower (hp), and the hoods remove a nominal 24,200 CFM of exhaust from the kitchen. (A make-up air unit was not in service; normally it would also be operated by the same controller.)

Lessons Learned

- Close coordination with both the facilities and kitchen staff is needed to ensure the installed equipment is accessible but does not interfere with normal operations.
- Not all exhaust and make-up air fan motors are good candidates for DVC. It may not make economic sense to control smaller motors of 2 hp or less.

IOU Partnership

The University of California/California State University (UC/CSU) and Investor-Owned Utility (IOU) Partnership Program has identified an incentive for this technology based on the energy saved per year. This is typically enough to pay for a significant portion of the installation cost.

Entrance to the campus Main Dining facility

Melink processor panel and fan motor VFDs

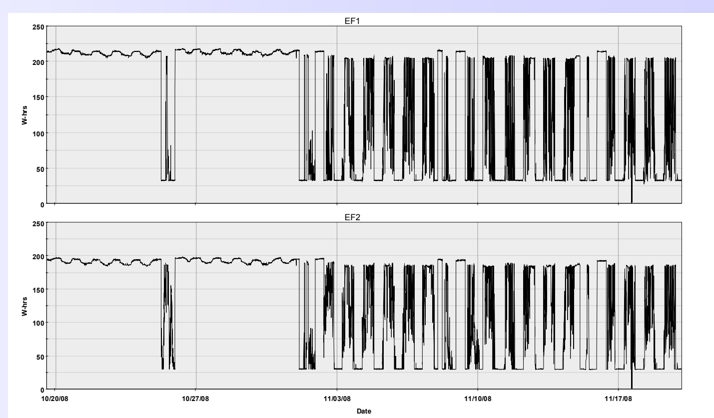
For more information please visit:
www.uccsuiouee.org

Installation Costs

The installed cost of a Melink *Intelli-Hood® Controls* package at any particular kitchen facility depends on how many control systems the kitchen needs -- there is a step up in cost every four hoods. Typical costs range from $14,000 to $32,000 per system, depending on the number of hoods and fans, and whether the work is new or retrofit. Costs for new construction cases are typically lower because installation complexity is reduced. Energy savings depend on the fan motor loads (kW) at full speed, the variability of the kitchen operation during the day, and the number of operating hours in the year. With the CCC/IOU Partnership incentives, the investment is often returned in just 2 to 5 years for retrofits, and in just 1 to 4 years in new construction!

Study Results

At Cal Poly San Luis Obispo, performance data was collected from mid-July to Mid-November, 2008. The chart at right represents the fan power history over a 4-week period before and after installing *Intelli-Hood®* Controls. Notice how the fans operated continuously at full power before the retrofit (except for Saturdays), but that the power level varies considerably throughout each day after the retrofit.

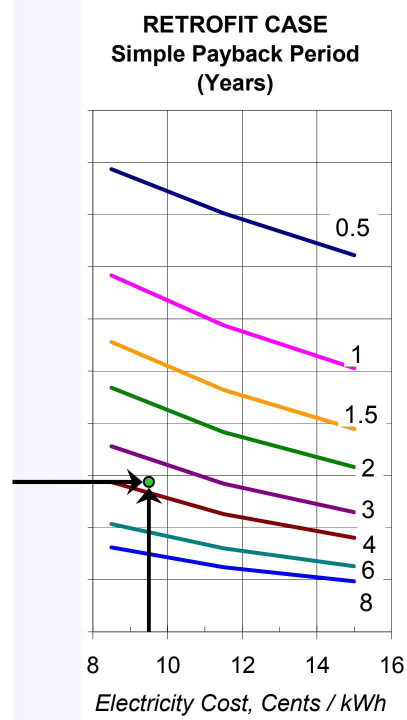


Pre-Retrofit Post-Retrofit

Study Results (cont'd)

For the three 3-hp fans, the total annual energy savings are projected to be 32,000 kWh – *about 54% of the previous usage* – and $3,030 in fan energy alone. Heating energy savings (est. 6,600 therms/year, about 33% of annual consumption) increase the total savings to $9,600 per year, resulting in a net payback period of 5.5 years. The IRR is 21%, based on a 15-year life. These savings are based on energy rates of $1.00/therm and $0.095/kWh. ***Considering the $14,200 IOU Partnership Program incentive for this demonstration project, the simple payback is 4.0 years.***

Payback (for UC/CSU campus retrofits with IOU Incentives)



kWh/yr saved

The above nomograph can be used to estimate fan energy savings for up to four motors and the simple payback period for the DVC retrofit. Starting with the installed total horsepower of the motors on the horizontal axis, go up to the line representing the number of hours the fans operate in an average week. At left-side vertical axis, read the kilowatt-hours per year that can be saved. In the table on the right side, for the cost/kWh for your facility, read the SPB. Heating and cooling energy cost savings are assumed to be 50% of the fan cost savings. The heating and cooling savings are variable for each installation, and depend greatly on the local climate and whether or not the kitchen is mechanically cooled. The chart assumes motors are 78% loaded and 84% efficient. New construction costs are typically lower due to reduced complexity of installation. Retrofit case SPBs are shown next to the graph, new construction SPBs are shown to the right.

An example is shown for the Cal Poly Main Dining system. The low total fan power (9 hp) is offset by the long operating hours (the fans run continuously), leading to a reasonable simple payback period.

Considerations

Since the DCV system will run fans at full speed only when required, a high exhaust airflow capacity can be specified in the design (ensuring a high safety factor), and the energy consumption during operation will be equivalent to that of a lower-capacity fan system. Tailoring the controller programming for each equipment line and hood during system commissioning will optimize hood performance and energy savings.

Each Intelli-Hood processor can receive inputs from up to four separate hoods and then control the VFDs for each hood's accompanying exhaust and supply fans. Cost-effectiveness increases proportionally to the ventilation system size and airflow rates. Aside from the incremental cost difference for larger VFDs, the installed DVC system cost per hood is relatively independent of exhaust capacity. Furthermore, an estimated $2000 per system can be saved if installed during new construction or remodel as opposed to a retrofit. One caution, take care at the design stage to provide kitchen make-up air from a separate unit, not the main building HVAC system, so that the make-up air can be controlled in conjunction with the exhaust fans.

Conclusion

Demand Ventilation Controls are a cost-effective solution to reducing the energy load and cost associated with operating kitchen exhaust systems in college foodservice operations. DVC can also reduce electricity demand during peak utility periods because average reductions in fan power are realized throughout the day (see illustrated load profile). Although the DVC retrofit cost can be significant with respect to an operating budget, the investment will usually be returned within two to four years. And the bonus for kitchen staff will be an improved working environment with dramatically reduced noise levels from the exhaust ventilation system.

Availability

The Melink *Intelli-Hood® Controls* package is available directly from Melink Corp. or *Intelli-Hood® Controls* dealers. Several major hood manufacturers are now supplying DVC as a factory-installed hood option. Two hood manufacturers (Captive-Aire Systems, Inc. and Spring Air Systems, Inc.) have introduced lower cost DVC systems that utilize temperature-only based sensors to modulate fan speed. It is anticipated that the energy saving potential of the lower-cost strategies will be reduced to some degree. However, both of these two manufacturers also offer Melink controls as an option.

About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) program. PIER supports public-interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

For more information see www.energy.ca.gov/pier

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