More Energy-Saving HVAC Tips for Green Buildings

An Online Continuing Education Course for Engineers

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A. Bhatia, Mechanical Engineer

Introduction

Green buildings! Green technology!

We hear these catch-phrases quite frequently these days. What exactly do they mean? Incorporating excellent practices that result in environmental protection, water conservation, energy efficiency, usage of recycled products, and renewable energy is termed "green." A "green building" is one that is environmentally responsible, profitable, and a healthy place to live and work. Green buildings ensure that waste is minimized at every stage during the construction and operation of the building, resulting in low costs.

Green building applies to both existing and new constructions, from a simple commercial space to large development projects. The Leadership in Energy and Environmental Design (LEED) Green Building Rating System is used as a benchmark for evaluating the design, construction, and operation of high-performance green buildings. LEED is often used as a qualifying criterion for a growing array of state and local government initiatives. What many facility managers may not realize is that it is an easy list of steps worth adopting, even if LEED certification is not being pursued.

Green HVAC Design

Concerns about healthy indoor environments, maximum energy-efficiency, and thoughtful use of natural resources/water—also happen to be the current concerns of the HVAC industry.

To improve a building's overall efficiency, it is helpful to understand what sources of heat gain/loss create the greatest cooling/heating load on the HVAC system. By reducing those loads, HVAC energy costs can be lowered, and comfort often can be improved. When designing a comfort system, it is not adequate to merely produce a heat loss/gain estimate and select high-efficiency equipment; much more is involved in the proper design and installation of a comfort system. Air handling and distribution system (ductwork, dampers, etc.), hydronic distribution systems (pumps, piping, fittings, etc.), delivery equipment (fan coil units, induction units, baseboard heaters, grilles, registers, etc.), and the control system make an important contribution to the performance and efficiency of the system as a whole.
The total performance of a building depends on a balance of envelope, mechanical systems, occupants, and external environment. All these parts of the building affect the flow of heat, air,

and moisture into and out of the building. Every subsystem should be designed with these concepts in mind to minimize the flows of heat, air, and moisture through the building envelope. Heat flow that escapes from the building wastes precious fuel, air leaking out carries both heat and moisture, and moisture that escapes from the interior of a building can condense or freeze in the insulation, reducing the effectiveness of the insulation and causing damage by mold and rot. In this course, we will look at some key elements related to HVAC and building design.

The green HVAC tips noted in this course are by no means exhaustive; keep in mind that the conservation strategies for greening may vary from region to region. Specific strategies should reflect the region's climate, material availability, and building practices. Keeping abreast of developments in real-time requires continuing education.

The content in this course is as follows:

Green Tip #16: Air Handling Systems

An air handler, or air handling unit (often abbreviated to AHU), is a device used to condition and circulate air as part of an HVAC system. Usually, an air handler is a large metal box containing a blower, cooling and/or heating coil, filter racks, sound attenuators, and dampers. Air handlers usually connect to ductwork that distributes the conditioned air through the building and returns it to the AHU. Sometimes AHUs admit (*return*) air directly from the plenum space above a false ceiling without ductwork.

The amount of air delivered to a conditioned space is governed by one or more of the following:

- Heating and/or cooling load
- Delivery temperature
- Ventilation requirements (exhaust, people, infiltration)
- Air circulation (air changes)

The design of both comfort and many industrial air condition systems requires that, for good air circulation, the amount of supply air should provide an air change every 5 to 10 minutes. Many systems are designed for a 6- to 7-minute change. Reducing airflow will reduce fan horsepower (1.8 to 2 CFM per square foot, 10-foot high ceiling).

Air handling Units Configurations

Air handling units can be either blow-through or draw through.

<u>Blow-through units</u> add fan heat (usually equivalent to 2-3°F) before the cooling coil. This maximizes the temperature rise between the cooling air and the space design temperature or minimizes the amount of supply air needed to condition a space. Since the air is often saturated and moisture problems may occur, a blow-through design should not be used with final filters downstream of the coils.

<u>Draw-through units</u> add fan heat after the cooling coil and typically need 10% more supply air than blow-through units to achieve the same zone cooling effect. This added supply of air increases the duct size requirement and fan operating costs. Moisture is less of an issue with draw-through units because the fan heat helps to reduce the saturation of the supply air.

Air Handling Unit Components

Fans

The electrical energy used to drive the fan motors is often the largest part of the total energy cost. Efficient fans and motors will obviously reduce energy costs.

There are two main types of fans: centrifugal and axial. Centrifugal fans are most prevalent for air handling applications, whereas axial fans are most commonly employed for ventilation and exhaust applications.

Centrifugal fans incorporate several types of fan blades—forward curved, backward curved aerofoil blades, radial, etc. Backward-curved Airfoil impellers provide the highest efficiencies for centrifugal fans. Their efficiencies range from 70 to 80% and can be as much as 30% more efficient than the typical forward-curved fan.

When selecting the fan, estimate the static pressure accurately. Anything that contributes to the obstruction of the free flow of air imposes a resistance to flow, which the fan has to overcome. Filter, coil, ducting, and distribution systems all impose resistance and all restrict flow to a degree. This restriction is known as system resistance (or pressure drop) and a vital part of the fan selection. The chosen fan must overcome this system resistance and still move the required volume of air. Of course, it would be easy to fit an oversize fan but, cost, size, efficiency, noise levels, and energy consumption will suffer.

The method used in reducing the system's airflow has a great influence on the amount of horsepower saved. Three methods normally used are:

- Fan discharge damper
- Fan vortex damper (fan inlet)
- Fan speed change

Of these fans, speed change is most efficient (refer HVAC tip #17 for description).

Fan Drive Motor

Electric motors are generally most efficient when operating from 75 to 100 percent of full-load capability. An oversized motor is often needlessly inefficient because of light-load operation—particularly if it is operating at less than 50 percent of full load.

When it comes to efficiency, all motors are not created equal. The difference between two seemingly identical motors can be vast, especially in the case of small, single-phase motors. Motors for fans with 1 horsepower or greater should meet NEMA premium efficiency motor guidelines when available as an option (see www.nema.org).

There are no LEED points specifically associated with drive power. However, LEED points are available for beating the ASHRAE 90.1 energy specification. In this regard, efficient drive power system design, the selection of premium-efficiency motors, and the use of VFDs can contribute to LEED certification.

Belt Drives

Belts are often used to transfer power from the drive motor to the equipment being driven.

1. Standard V-belt drives can be found in the majority of belt applications, as they are the lowest cost option of the belt family. The trade-off, as usual, is in energy efficiency.

2. V-belts, when new, can typically achieve efficiencies in the 90 to 95% range. A worn belt, however, can considerably reduce the efficiency due to slip caused by slackening and worn grip surfaces.

3. Cogged V-belts are similar to stan... ...ally flat underside has longitudinal groov... ...ndard V-belts. They typically offer a 2...

4. Synchronous belts c... ...izing slip and improving efficienc...

Filters

Filtration has a substantia... ...drops of up to 0.072 pounds per square i... ...of fan power. As with other air-handling co... ...velocity (airflow per unit area of filter medi... ...*efficiency* of a filter refers NOT to energy... ...m the airstream. Pressure drop is the measu... ...to move air through the filter, and it var... ...cal HVAC-duty filters (30 percent ASHRA... ...drop is 0.0036 psi. Dirty, thick, or poorly d... ...ops as high as 0.072 psi—as much as the entire frictional ... system.