SASKATCHEWAN ENERGY MANAGEMENT TASK FORCES

TECHNOLOGY INFORMATION SHEET

HVAC AIRFLOW & PUMPING

Background

Approximately 15 - 20% of electricity use in commercial buildings is for air movement. The minimum ventilation rate is dictated by the number of occupants and the strength and type of indoor contaminants. Most of the air is circulated to maintain an acceptable comfort level (usually temperature driven) for the occupants and to remove any contaminants (CO_2, dust, smoke, etc.).

In addition to the energy used for ventilation, from 5 - 10% of the electricity used in commercial buildings is for pumping water. The output requirements of both the ventilation systems and the water systems are usually variable. Equipment is usually sized to meet peak loading needs and as a result, most equipment is operated at less than full load for extended time periods. Therefore, these systems can easily be targeted for efficiency improvements.

High Efficiency Fans & Pumps

Centrifugal fans and pumps are most commonly used for HVAC and water supply applications. Fan and pump efficiencies are determined from a number of factors. Improved impeller blade shapes and configurations, improved housings, and better designs for ducting/piping connections have all lead to improved efficiencies. Replacement of existing equipment with newer designs may lead to system problems if care is not taken, since the newer designs may produce more output from a given motor drive.

High Efficiency Motors

The replacement of standard motors in HVAC and pumping systems with premium efficiency motors can reduce the amount of electricity used for drive-power. Refer to the SECDA information sheet *High & Premium Efficiency Motors (TIS-L0002)* for the savings potential with this energy saving option.

Proper Duct & Piping Design

Both duct and piping designs are dictated by the needs of the building occupants. The design of the ducting and piping to supply these needs predetermines the sizing of the fans and pumps and, therefore, predetermines the size of the motor drives. It is important to recognize the relationship between the flow of the fluid (air or water), and the pressure drop of the system.

The power requirements for a fan or pump motor are proportional to the cube of the fluid flow rates. Therefore, a 20% drop in flow rate can result in a 50% decrease in the power requirement. Similarly, a 50% decrease in power requirement can be achieved by a 13% increase in cross sectional flow area duct (or pipe diameter) due to the reduction in fluid friction losses. Unfortunately, the increase in size brings added costs. An iterative procedure must be used to determine which size of equipment should be applied to achieve optimum performance at the lowest cost (capital and operating costs).

Variable Air Volume Air Circulation

Many older building ventilation designs are based upon a constant rate of air supply. The air is supplied by constant volume (CV) flow fans to give constant air volume (CAV) ventilation. This ventilation design is applicable to building cores with constant occupancy but is not an efficient method of ventilating variable load spaces. Variable air ventilation (VAV) systems supply air according to the actual heating/cooling loads of a given area (or for grouped areas - the requirements of the area of most demand). The air flow can be varied by dampers or by variable pitch fans. Both of these are less efficient than varying the motor speed with an adjustable speed drive. Temperature sensors can be used to control the fan speed, achieving a reduction of electricity use up to 30%. See the SECDA information sheet *Adjustable Speed Drives (TIS-M0003)* for more information on this energy saving option.

In a cold climate like Saskatchewan, VAV systems must be modified to meet the heating and cooling loads. This is most easily accomplished by using a dual duct system for both hot and cold supply air with a terminal box to mix the two.

Displacement Ventilation

Displacement ventilation differs fundamentally from conventional ventilation schemes in that it attempts to minimize the mixing that occurs in any given room. Cold air is introduced at floor level at flow rates up to ten times lower than conventional ventilation flows. The cold air disperses across the floor of the room and as it gains heat, it rises. As the air rises, it becomes more contaminated and it is removed from the room at ceiling level. Because of the low flow rate of the supply, minimal mixing occurs and the effect is that of a plug of air moving upward through the room. The air removed has the highest temperature and the highest contaminant level.

The advantage of the displacement ventilation scheme is that ventilation air is supplied at a colder temperature so it can be supplied at lower flows and still maintain an acceptable temperature in each room. The reduced flow requirements reduce the energy input to move the air through the system. In addition, the scheme has been shown to improve the air quality overall.

Displacement ventilation is well suited to the core space of buildings but it does not suit perimeter areas due to their heating requirements.

System Optimization

In new construction and retrofit situations, a number of steps can be taken to ensure the highest possible operational efficiency. The following steps should be noted for optimum system design and operation:

1) Reduce restrictions in duct and pipe work. Gradual bends and larger sizes, where possible, reduce pressure drop and therefore decrease the power required to move the fluid.
2) Change constant volume flows to variable volume where possible.
3) Reduce flow volumes by increasing or decreasing the temperature of the supply of air, water, or both. A colder temperature makeup air supply means that less of it is required for cooling purposes. Similarly, water used as a cooling medium for a heat exchanger will adsorb heat faster if it is supplied at a colder temperature (the difference in temperature of the heating and cooling mediums drives the rate of heat exchange).
4) Regulate pressure in VAV systems by regulating to the requirements of the worst

zone. Therefore in a VAV cooling system, the warmest zone would dictate the supply pressure.

5) Replace inlet vanes or dampers with ASD-motor systems for improved energy efficiency.