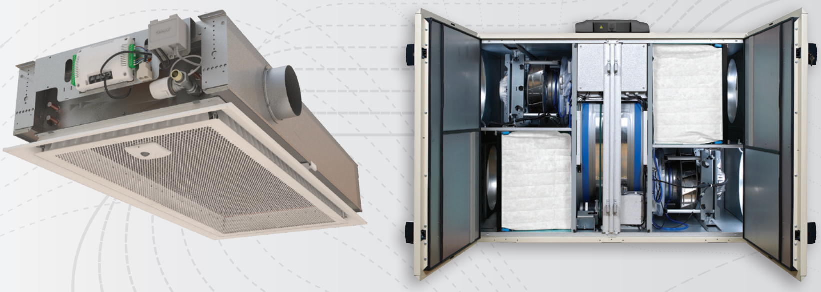
October 2015, Issue II
Energy-Saving Comfort

In this issue

1. Demand Control Ventilation (DCV)
2. Dedicated Outdoor Air Systems (DOAS)
3. Swegon GOLD DOAS Air Handling Unit – launching in North America in December 2015



1. Demand Control Ventilation (DCV)

Conditioning ventilation air is very costly in the winter and summer months, so managing the volume of outside air to meet indoor air quality requirements can offer significant energy savings. Studies have shown that this savings can be as much as 70% over a CAV system. Demand control ventilation (DCV) can be used with a variety of systems such as variable refrigerant flow (VRF), water source heat pump (WSHP), fan coil or chilled beams.

DCV varies the amount of primary air to maintain air quality based on a VOC (volatile organic compounds) or CO^2 (carbon dioxide) level, which can offer savings in a couple of ways. Studies have revealed that classrooms have actual occupancies of 25% to 35% and offices 22% to 45% during normal operating hours.

The ventilation system can be reduced to 30% or below during these unoccupied periods which offer significant savings on design days. (Fig. 1)

The second savings opportunity comes with reduced occupancy. If a classroom designed for 25 students is at full occupancy, the ventilation system will operate at 100%. If, however, the room has only three occupants, you will quickly over-ventilate with a CV system dropping the CO^2 count to near outdoor levels of 400 PPM when 800 PPM – 1000 PPM is acceptable. This over ventilation costs both fan and thermal energy.

Reduced occupancy savings come in three areas. First, the fan energy is reduced based on the reduced air volume. Second, the chiller or boiler load is reduced based on the reduced airflow. Third, the pumping energy will be reduced due to the reduced chilled/hot water load.

Fig 1.

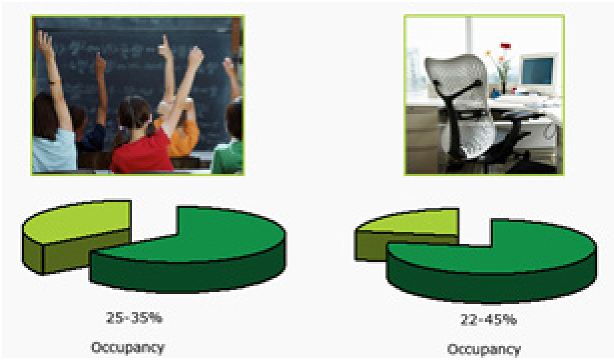
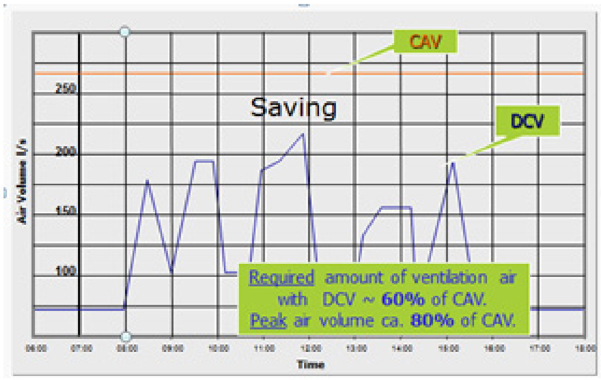
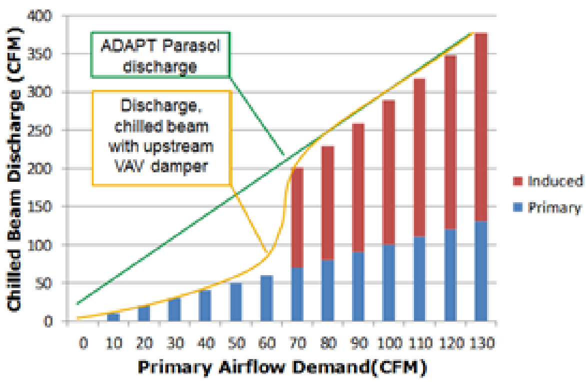


Fig 2.

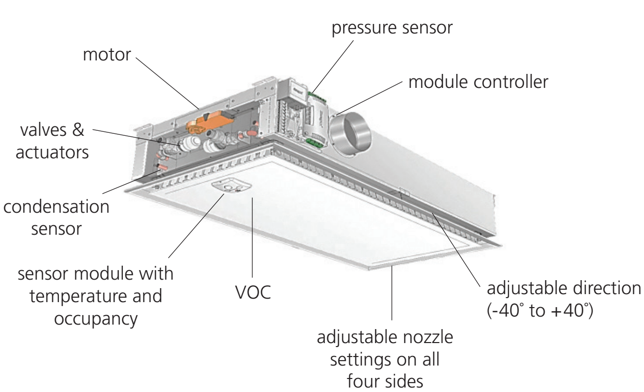


The area between the CAV red line and DCV blue line represents energy savings

In a chilled beam system, the Swegon ADAPT Parasol comfort module will control the ventilation rate to maintain the CO^2 or VOC level, which could be as low as 20% of the design ventilation rate. The ADAPT Parasol varies the air volume inside the module by closing induction nozzles to maintain the design induction ratio, thus maintaining the heating or cooling capacity as a percentage of airflow. Other manufacturers place a VAV damper device upstream of the chilled beam(s), which reduces the primary air volume but because the nozzle area remains constant, the induction ratio drops off severely below 70% of the design flow. This reduced induction greatly reduces the cooling or heating capacity and often causes the chilled beams to “dump,” creating drafts and discomfort. This chart illustrates the difference in air volume delivered to the space between these two DCV control strategies.



ADAPT Parasol – Demand Control Ventilation (DCV) Comfort Module



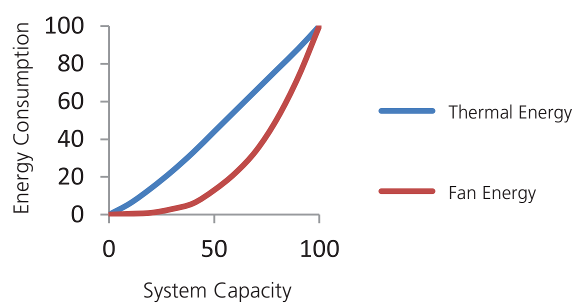
The Swegon DCV ADAPT Parasol with factory-mounted integrated controls

HOW MUCH SAVINGS CAN WE ACHIEVE WITH DCV?

Considering the two main energy saving sources are thermal and fan energy, the real savings value is the fan energy. If we reduce the CFM by 30%, the thermal load reduces almost linearly by 30% as well (the pumps represent 20% of the energy that is subject to the same energy laws as the fans). Fan energy, $nEv = \frac{1}{2}Mv^3t$ reveals fan energy to decrease in proportion to the cube of air velocity. In any given ventilation system, the air velocity varies with the air demand – doubling the supply air requires doubling the velocity, in which case the fan energy would increase by a factor of eight $(2)^3$. Conversely, if the air demand is halved, the fan energy would be reduced by a factor of 8.

For example, a 30% reduction of ventilation air would lower the fan energy demand to $(0.7)^3 = .34$ or 34% of the original, thus savings 66% of the former fan energy compared to a 30% reduction in thermal energy reduction for the same air flow. With less ventilation air, fan energy is reduced far more than thermal energy due to its cubic dependence on air volume.

Energy Consumption vs. System Capacity



To calculate the total energy savings, the most important factor is the simultaneity factor S, which indicates what fraction of the rooms in the building are occupied at any time. S may be found empirically for individual buildings but normal S values are 0.4 to 0.9 with 0.6 being a typical value for commercial office buildings. S provides a measure of how much ventilated air can be used making S and velocity linearly connected. From this, thermal energy demands are reduced in proportion to S and fan energy requirements are reduced by the cube of S.

If a building energy $E_0 = A_0 + B_0$ where A is thermal and B is fan energy, without energy recovery, the thermal energy is typically greater than the fan energy (e.g. $A=0.55E_0$ and $B=0.45E_0$). With the introduction of energy recovery at 70% efficiency, the thermal energy will reduce by a factor of F=0.6 while the fan energy remains the same. This would save 40% of the thermal energy amounting to 22% of the original E_0 making the fan energy the dominant with $A=0.33E_0$ while $B=0.45E_0$. This makes the fan energy 58% of the total energy consumption. DCV without (F=1) or with (F=.6) energy recovery thus may reduce the total energy E needed for thermal and fan as calculated below.

Reduced energy demand with DCV: $E = FAS+BS^3$

Total energy savings using DCV: $QE = E_0 - E$

Energy Savings with DCV

S-Factor	Without energy recovery $A=0.55E_0$ $B=0.45E_0$	With energy recovery $A=0.33E_0$ $B=0.45E_0$
1	0%	22%
0.9	18%	37%
0.8	33%	51%
0.7	46%	61%
0.6	57%	70%
0.5	67%	78%

This table indicates what savings can be realized with DCV. With or without energy recovery, the savings can easily approach half of the original energy. More exact calculations would require detailed information about the energy distribution in a building but the table shows that DCV is a more powerful energy saver than energy recovery. If the building is already equipped with energy recovery, the fan energy may represent 70% of the remaining energy usage.

SUMMARY

DCV should be considered on all buildings with variable and unpredictable occupancy levels.

2. Swegon Gold Dedicated Outdoor Air Handling Unit

We looked closely at the energy savings potential of a DCV system, so now we'll look at one of the key components: the dedicated outdoor air unit. Essentially these units replace the conventional exhaust/make-up air systems and in chilled beam systems, handle 100% of the latent cooling load. Energy reduction demands and regulatory compliance have pulled these units into the HVAC mainstream. All DOAS units are equipped with an exhaust fan, supply fan, and an energy recovery system. The standard in commercial and institutional construction is the total energy air to air rotary heat exchanger, which offers high efficiencies (80%), low maintenance and is relatively compact.

There are three major benefits of DOAS units:

A. First Cost Subsidy

The energy recovery amount can be deducted from the heating and cooling loads reducing the capital cost of this equipment.

Applying the formula, $Q_t = E \times 4.5 \times V_{min} (h_1 - h_2)$

Where:

Q_t = total heat flow, Btu/h

E = sensible, latent or total effectiveness

V_{min} = the smaller air flow (supply or exhaust)

h_1 = entering supply – air enthalpy, Btu/lb

h_2 = entering exhaust – air enthalpy, Btu/lb

Mechanical Cooling Capacity Reduction Example:

7000 CFM Central Exhaust

Total energy recovery of 80%

Cooling Design

Outdoor Air:

92F DB, 74F WB, 37.2 Btu/lb enthalpy

Return Air:

78F DB, 63.5F WB, 28.8 Btu/lb enthalpy

Q_t = .80 × 4.5 × 7000 (37.2 - 28.8)

= 211,680 Btu/h

211,680 Btu/h /12000 = 17.64 Tons

Summary

At $500/ton, this capacity savings represents $8,820 of capital that can be shifted from the chilled water plant to the DOAS unit.

B. Operating Cost Savings

Using the weather data for a particular city, we can determine the operating savings through energy recovery. We have a slight pressure drop through the wheel (.8” wc) and the wheel drive energy (130 watts), but these are minimal compared to mechanical cooling .5 to 1.1 kW/ton.

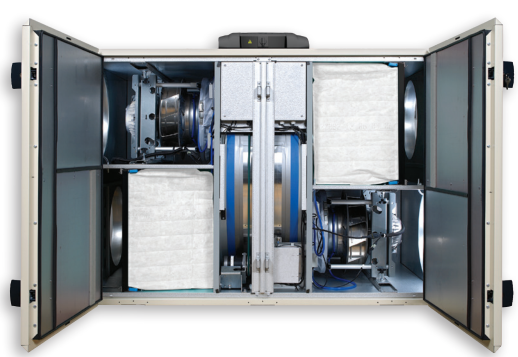
Using the weather data for the location used in this example, our annual chiller plant operating savings would be approximately $4300 at $.11/kWh.

C. Reduced Maintenance

Maintenance on a DOAS unit is much less than on a chiller, pumps, and cooling tower. A typical chiller plant annual maintenance budget is $100/ton which in this example provides $1764 (17.64 tons × $100) in savings. With good filtration (MERV 11 or greater) a rotary energy recovery wheel will operate 7 to 10 years between cleanings within 90% of its design efficiency (cleaning involves vacuuming the exchanger or in extreme cases, removing and applying a cleaning solution).

The Swegon “GOLD” DOAS unit

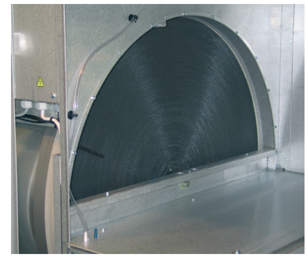
Building owners today are looking for a small footprint, longevity, low maintenance and energy efficiency in their HVAC designs. The Swegon GOLD DOAS unit has been fulfilling these needs since the early 1990s in Europe with over 82,000 installations worldwide. Now in its 5th generation, the GOLD unit will be manufactured and launched in North America in December 2015. GOLD carries the smallest footprint, offers the highest efficiency energy recovery wheel, has the highest electrical efficiency with EC motor technology, is equipped with BACnet and Wi-Fi integrated controls, and is the quietest unit on the market.



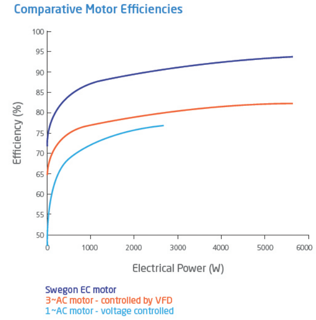
GOLD DOAS Unit 3000 – 16,500 CFM

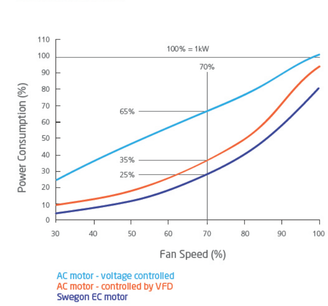
The rotary heat exchanger and fan assembly efficiencies determine the units overall efficiency. The following charts illustrate the energy-saving advantages of EC motors.

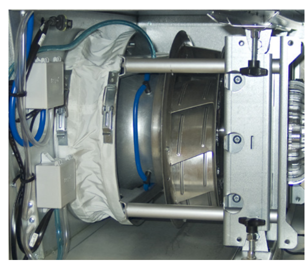
Right: Rotary heat exchanger: up to 85% energy recovery



EC vs. AC Motors/Fans







The EC motorfan assembly is designed and tested as a unit guaranteeing the energy performance.

The unit is being built in North America and, due to the highly automated manufacturing and assembly processes, is one of the most competitively priced units on the market with standard lead times of six weeks.

GOLD RX
Double wall construction with baked enamel finish

Want to see and hear a unit in operation? We have a fully operational chilled beam/DOAS system in our new Comfort Training Center in Markham.

Call or email your Regional Sales Manager to arrange a visit.

Next Issue

1. Swegon Comfort Training Center: Our new training facility opens in this month! Stay tuned for our open house invitation and chilled beam system and primary air ventilation design training courses.
2. Decentralized Ventilation
   a. Optimize your energy usage by separating your different ventilation rate requirements in multi-use buildings
   b. Locate the DOAS unit closer to the area it serves
   c. Free up valuable leasable space
   d. Look at first and operational cost savings on implementing these strategies.
3. DesignEdge – Swegon's chilled beam design-assist service to help minimize consultant's time

Please feel free to contact us if you would like more information on chilled beam systems, GOLD or to schedule a technical training session.

Best regards,

Canada

Mark Moore
Canadian Sales Manager
1-800-565-8401 ext. 5367
Direct: 647-258-5367
Mobile: 647-207-5008
mark.moore@swegon.com

Mid-Atlantic USA

Matt Pemberton
Regional Sales Manager
Direct: 573-554-6033
matt.pemberton@swegon.com

USA

Mike Woolsey
Business Development Manager
1-800-565-8401 ext. 5405
Direct: 952-564-6034
Mobile: 612-685-6519
mike.woolsey@swegon.com