Making an impact on building emissions

By Andrew Sargent, General Manager of Advanced Air

When designing an energy efficient building the obvious targets are those that make the most impact and with building services systems it is likely to be the chiller, lighting and glazing.

Assuming a building is being designed to meet or exceed the new 2010 regulations then the proportions of carbon emissions will change radically from, say, a building designed 10 years ago. Typically the carbon emissions of this new building will come from a third lighting, a third cooling/chiller and a third others, which include terminal fans, air handing unit fans, pumps and heating.

Terminal fans as used in fan coil units have been regarded as low energy consumers within the total energy consumption of the building up until recently. With significant reductions in energy consumed by the lighting and chiller being made in the design to meet the building regulations it has dramatically increased the proportion of energy consumed by other parts of the air conditioning system, notably the terminal fans.

If AC motors were used within a fan coil system of a 2010 compliant building then the energy consumption of the terminal fans could be over 15% of the total building energy consumption. Although this figure is unbelievably high, it is a fact that can be proved through Dynamic Simulation Modelling of the actual building's projected energy usage.

In other words all the saving in energy on the so called big hit items like the chillers and lighting have magnified the energy consumption proportions of the lesser items such as terminal fans. The perception that the terminal fans are only a relatively small proportion of building energy usage is out of date, totally wrong and totally inaccurate. It means therefore that designers now need to look carefully at the fan deck design of the fan coil units if they are going to further reduce the total building emissions.

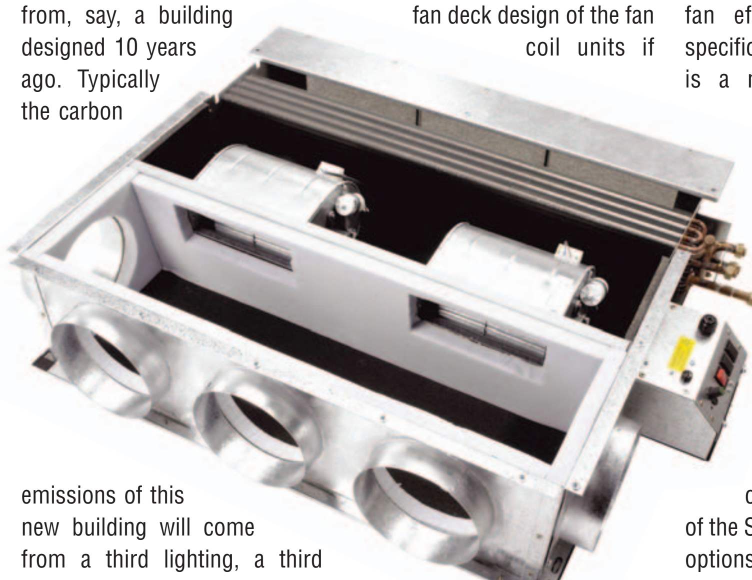

Figure 1

Fan deck design

Up until recently fan decks have been designed by specialist suppliers utilising AC motors, either the permanent split capacity (PSC) type or external rotor motors (ERM). The fan deck normally comprises a number of small fans – usually three but could be up to five vertically mounted across the width of the fan coil unit. This vertical mounting of the fans meant that multiple units were utilised to keep the height to a level where the complete fan coil assembly could easily fit into the ceiling void. This conventional fan deck is shown in figure 1.

EC motors

Prior to 2002 fan coil power consumption was a relatively small proportion of the building energy consumption and low efficiency, inexpensive AC motors were widely used. The efficiency of these motors is very low and often operates at less than 25%. The working range of efficiencies is as low as 10% and seldom exceeds 40%. EC motors, on the other hand, are much better with efficiencies up to 70% which can significantly reduce the motor power consumption.

Within the Building Regulations Part L currently 2006 a measure of motor and fan efficiency is related to specific fan power or SFP. This is a measure of the watts required to create an airflow in l/s. In current regulations an SFP of 0.8 is used as a guide, however the 2010 figure will be much lower and probably around 0.6w/l/s. In other words to create an airflow of 1l/s, 0.6 watts would be consumed. A comparison of the SFP for a range of fan coil options is shown in figure 2. The development of EC motors for use with fan coils copied the convention of vertically mounted centrifugal fans. The only European motor manufacturer of EC motors launched a range of small 75 watt motors so that a motor for each fan shaft was required. Although these motors were highly efficient there was a premium of around £35 per motor and with three motors in the most popular fan coil size the premium was over £100.

At Advanced Air we developed with our parent company in the USA, Nailor Industries, a much larger EC fan coil motor option (250 watts compared to 75 watts currently available in Europe). By cleverly turning the fan on its side (see Figure 3) and mounting it horizontally we were able to restrict the height to 280mm and only use one fan and motor for the most popular fan coil sizes.

The EPIC fan coil unit with the horizontally mounted fan could achieve the airflows with the single larger fan running at lower speeds compared to the conventional EC fan decks. This resulted in lower noise levels or for a given NR rating, say NR35, the EPIC unit allows a smaller sized fan coil to be used with a consequential reduction in price. The combined cost savings from the single motor and smaller sized fan coil unit means that the payback period for the EPIC fan coil could be measured in months, not years.

Most consultants are positively specifying that only EC motors are to be used not only for their carbon credentials but for other benefits too. These include the fact that the fan speed of an EC motor can be infinitely variable and is also relatively easy to achieve. Factory setting of air volume can be set direct from the BMS system or through the in-built unique EC control card module.

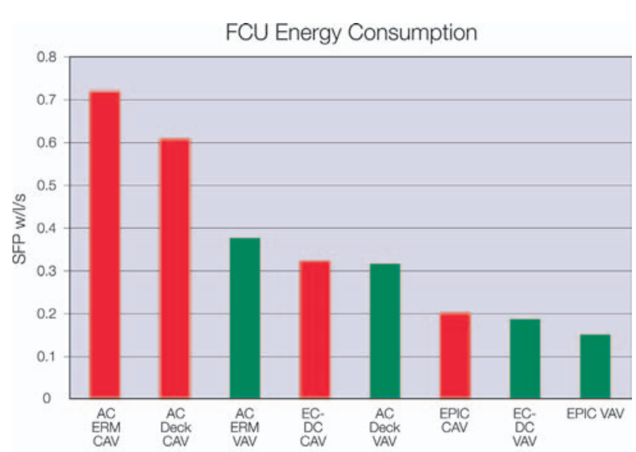

Figure 2

The volume can be set by a 0-10 volt control signal which, via a control system, is ideal for the utilisation of VAV capability to suit varying occupied space loads.

Due to its smart motor technology the fan is self-commissioning as any change in external resistance is recognised by the smart controller and the fan automatically compensates to achieve its set point. The step-less dynamic speed control compared to standard step control gives greater operating range and more flexibility. The smart motor has feedback capabilities which via the BMS can be used to indicate dirty filters and can be programmable to suit varying room condition loads.

Soft start and slewed speed ramps are programmed into the motor which eliminates stress to the mounting bracket or hardware. This is one of the factors in higher life expectancy of 90,000 hours (approximately 20 years) compared to the expected 50,000 hours (10 years) of typical PSC motors, resulting in fewer failures and lower maintenance costs for the life cycle of the building.

VAV fan coils

For the last 40 years virtually all fan coils have been constant fan speed and consequently constant air volume (CAV). Any changes in cooling or heating were adjusted by the water valve, i.e. varying the water volume. However with the fans running at full speed all of the time this is a needless waste of energy.

By varying the air volume, significant reductions in energy can be achieved and typical values of SFP for a wide range of constant and VAV fan coils is shown in the energy comparison graph figure 2.

The control philosophy is relatively simple - at maximum cooling the fan is running at 100% with the water valve fully open as the cooling load reduces the fan air volume is reduced down to a minimum of 60%. If the cooling load reduces further the water valve is progressively closed until the dead band is reached. In other words the fan air volume is reduced first followed by a progressive reduction in the water cooling volume.

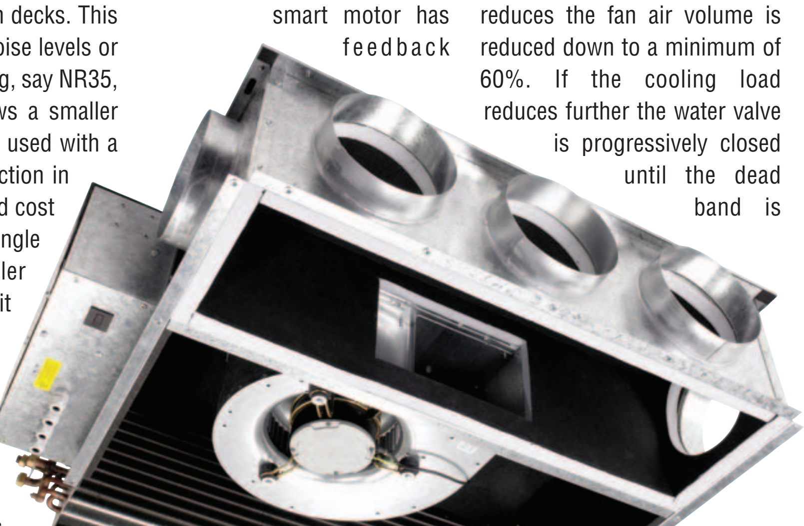

Figure 3

On heating the early morning boost has maximum air volume and heating. On the heating cycle the air volume is kept constant to ensure there is no stratification within the room. The heating requirement is usually a short period just prior to occupation of the building and therefore does not significantly impact on the carbon emissions.

This VAV option with the EPIC fan coil gives specific fan powers down to a very low 0.15w/l/s. With these highly efficient terminal fans the fan coil unit has similar carbon emissions to chilled beams and will make it the system of choice for many consulting engineers.