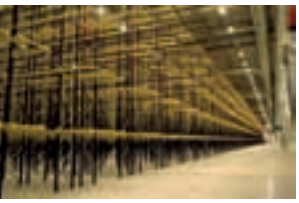

Above and right: Major Cadbury plant benefits from air induction equipment

Lou Boileau Photography

Plant, equipment and controls for HVAC are all evolving – and so are the environmental regulations that govern their use. So engineers need to keep up, suggests Brian Tinham

Blowing

Last summer's government energy strategy – which called for power generation from renewables to rise to 20% by 2020 and for CO_2 to be reduced by 60% before 2050 – is going to have a profound effect on plant, and that includes HVAC (heating, ventilating and air conditioning) installations. That's particularly the case in non-domestic buildings, where space and water heating account for significant energy use and emissions. And it's not only about increasing the use of air source and ground source heat pumps, or solar hot water systems: variable speed drives (VSDs) on existing fan and pump equipment, as well as CO_2-based building energy controls are among other technologies that need to play their part.

For plant engineers, change will be gradual, but it will come. The new European air quality monitoring standard EN 13779, for example, is already mandating defined filter performances for particulates in buildings – and thus also equipment choices and inspection and maintenance regimes. Similarly, the Energy Performance of Buildings Directive (EPBD) – which seeks to improve buildings' energy efficiency, in part through HVAC system choices and their operation – is making itself felt. It's not just about the certificate: first inspections of HVAC systems over 250kW had a deadline of last January and, next, those down at 12kW must be examined by 4 January 2011.

The result: we need to mug up. We need to re-check our understanding of good plant and system choices – and that includes revisiting some of the newer (and some not so new) technologies, such as evaporative cooling, so-called heat harvesters, better building management systems (BMSs) and the up-and-coming BACnet digital fieldbus for HVAC (see panel). We also need to ensure that we're up-to-date on skills (especially electronics) and best practice guidelines, in terms of installation, commissioning and maintenance engineering.

Looking first at increasingly popular CO_2 sensors for HVAC control (an approach that actually harks back to World War I), there are already fairly clear design and installation guidelines, according to Harry Swinbourne, sales director at Honeywell's CentraLine Building Automation division. The science is simple enough: since space is not always fully occupied – particularly in offices, schools, theatres, supermarkets and the like – energy is saved by reducing ventilation rates to match occupancy, using sensed CO_2 levels for control. Savings are said to be in the double digit per cent range, and users report increased plant life and reduced equipment noise as well.

For new systems, controls are designed to provide fresh air supply at minimum fan speed. But where existing systems have to be adapted, Swinbourne suggests several choices. In small installations, straightforward fan switching may be acceptable, following CO_2 sensor output, although there must be a sensor limit switch. Meanwhile, systems with mixing chambers can be extended to CO_2 control by providing a means to select the signal from the temperature control and air quality control. Extension kits are independent of the BMS.

Fresh air systems can also be extended with air quality control output to the fan frequency converter. Be aware, though, that in some cases the fan motor has to be replaced to work with a VSD. That done, the controls comprise a CO_2 sensor, a proportional controller and a maximising device. But, if your HVAC system has a mixing chamber and a frequency converter, only the BMS can provide the functionality, so it may be necessary to upgrade.

Carbon dioxide

As for the CO_2 sensors themselves, the latest units use infrared and are self-calibrating. They can also be bought with a built-in controller and/or limit switch. Swinbourne recommends that in large, open buildings, such as cinemas, the sensor should be installed in the air exhaust duct. However, in other buildings, wall-mounted units make more sense. By the way, air quality sensors based on oxidisable gases, such as odours and carbon monoxide, can be used, if CO_2 is not ideal, such as in restaurants.

Moving on to drives, recent years have witnessed huge performance improvements, so there are great opportunities for better energy efficiency, cost cutting, reduced maintenance and flexibility. However, VSDs manufacturer ABB reckons that 70% of building services consultants don't use up-to-date specifications. So it's worth knowing about its free publication, entitled 'VSD selection for

Pointers

- Government renewable energy strategy is turning HVAC plant choices
- CO_2 sensing is gaining popularity for energy-saving installations
- HVAC-specific variable speed drives, with pre-programmed functions, are not on the radar
- Evaporative cooler plant is further improved
- Air induction technology is proving capabilities
- Heat harvesters offer a low-cost recovery option
- BACnet HVAC fieldbus is seeing significant growth

hot and cold

building services: checklist for HVAC consultants'.

Key facts it alludes to include that HVAC-specific drives should now come pre-programmed with several application I/Os, such as supply and return fans, cooling tower fans and booster pumps. Connecting drives to the HVAC system is then easy, by selecting the pre-defined macros and connecting to the drives' fieldbus options. Also, many have built-in PID controllers to cope with demanding pump and fan automation requirements without buying and installing separate controllers.

ABB also points out that modern VSDs include chokes to reduce harmonic emissions in electrical supplies by up to 25%. This is important, given that since February last year there have been strict limits for products connected to 400V networks.

As for the difference drives can make, look no further than Plymouth-based semiconductor manufacturer X-FAB UK, which reckons it has been saving £31,400 per year since installing ABB HVAC drives to run six 37kW fan motors on three cooling towers. And that's not including reduced maintenance costs in terms of broken drive belts.

Originally, the fans were star/delta connected and arranged in cascade format, switching to follow demand. That resulted in the final fan turning on and off, sometimes every 10 minutes and drawing significant start-up current. Now, two fans start on the first towers at 20Hz; then, as more cooling is required, the BMS brings in the next two at 20Hz and then the remaining two. For further cooling, all six fans run together between 20 and 50Hz.

Ted Judge, X-FAB's senior facilities engineer, says the £15,000 installation provided payback in only six months. "I hadn't used drives much before Drive Control [the local ABB HVAC company] came along to give me a demonstration. I now see that VSDs are the most effective way for us to save energy."

Alternative plant

So much for improving existing HVAC plant; if you are about to specify new, pause for a moment to consider some of the alternatives – such as evaporative cooling or, on the distribution side, air induction equipment. Breezair, for instance, recently introduced its Icon range of centrifugal fan-based evaporative coolers, said to be maintenance free, and now consuming up to 40% less power than other simliar ducted systems, as well as 90% less than traditional refrigerated HVAC. Available from CoSaf Environments, its so-called Hushpower permanent magnet-based motors offer the extra base efficiency, while automatic controls optimise running, even to the extent of adjusting motor speed to match different ducting systems and back pressures. Other changes include an auto drain facility that monitors water quality, a Tornado pump and long-life Chillcell pads.

CoSaf also offers more conventional HVAC, always with an eye to environmentally-friendly

BacNet breathes in benefits

Over the last couple of years, HVAC and BMS companies have been reporting significant growth in uptake of the BACnet digital communications, which first emerged as a standard for building automation and control networks back in 1995. Why? Because, in much the same way as the competing fieldbus digital plant networks are revolutionising process industry monitoring and control systems, BACnet transforms what can be achieved with HVAC plant automation.

Teemu Heikkilä, one of ABB's BACnet experts, describes some of the advantages: "BACnet is designed for integration between different companies' devices – it's a common language for control system compatibility. It's also free: there are no licence fees. And it's not locked into any particular media. It can be used to run over Ethernet office and RS485 factory networks, for example – meaning that computer systems and HVAC controllers and devices can share the same data, via a router."

Compare that with traditional wiring, whether hard-wired, using multicores, or proprietary serial communications. Not only is it cheaper and easier – since one mixed-media network can accommodate multiple devices – but engineers can get remote digital access to, for example, drive data, such as running speed, energy consumption, running hours, motor values, output current, motor torque and the full drive parameter table.

"Also, for plant engineers involved with installation and commissioning, since all device set-up data is on the network, you don't need to know, for example, specific drive parameters before you start. You can do final tuning for precise control whenever you're ready," says Heikkilä.

Then, for maintenance, BACnet allows fault and diagnostic information to be routed not only to a control HMI (human machine interface), but also to maintenance engineers' laptops connected anywhere on the network, and to remote locations, with email fault alerting etc.

And one more point: systems are future-proof – meaning they can be changed or augmented whenever the need arises. So at ABB Marine's Azipod (see page 8) site in Vuosaari, Finland – where HVAC controls include 40 PLC-controlled ABB drives running pumps and fans for cooling, heating and air handling across three separate production halls and associated offices – the BACnet system is about to enable real-time energy monitoring, even though that wasn't originally specified. "We only need to configure the operator workstation for energy monitoring purposes," explains Heikkilä. "We won't have to reprogram the PLCs or drives."

Nick Payne, general manager at Building Environment Control (BEC), agrees. His company was responsible for the BMS at the Grade I listed Crewe Hall hotel and conference centre (above) extension project and for the Jackson House office block in Manchester – both based on BACnet and both also using ABB drives. "We have been installing BACnet systems for about 10 years now but, whereas two years ago about 25% of our installations used it, now it's nearer 45%. It's straightforward to use, with the right tools, and because the controllers, drives and equipment all use the same embedded open protocol, we can select the best plant for each application."

ABB's BACnet router: connecting plant and company networks

choices. The company recently installed decentralised plant, comprising 24 floor-standing and suspended gas-fired warm air heaters, and nine gas-fired radiant heaters for production buildings and workshops at Glusburn, North Yorkshire-based circlip manufacturer Cirteq. It also provided a gas-fired boiler, pressurisation system, new circulating pumps, flue dilutions and controls for the company's four-storey office block. And, with its optimised starting facility, this installation qualified for an Energy Efficiency loan from the Carbon Trust.

How about air induction technology? Jet Environmental claims fuel savings greater than 50% and commensurate carbon reductions, with relatively modest capital outlay, little or no disruption and complete flexibility in terms of space usage. Jet technical director Tony Gilbert suggests that it is an ideal choice for sports halls and warehouses, whether high bay (up to 40m, chilled or ambient) or low-rise, with deep racking and/or mezzanine floors. Incidentally, in production facilities, it can also provide for air makeup.

What you get is a series of self-balanced jet nozzles to direct medium velocity warm or cool air into the space from roof level – all connected via relatively small diameter ductwork to a centralised air handling unit. Compare that to low-velocity, large diameter ductwork or unit heaters, which then require de-stratification fans. Jet's equipment also accommodates any heating and/or cooling technology, whether heat recovery devices, such as geothermal or heat pump installations, or high-efficiency gas units and fresh air systems.

As Gilbert says: "Conventional alternatives often mean expensive over-heating or cooling to offset temperature stratification. That alone can make 20—30% difference to energy usage. Also, on the cooling side, fresh air ventilation means further savings, compared with split type mechanical air conditioning systems. Most of the time, our climate is cooler than the temperature you're trying to achieve in the space." He also makes the point that maintenance is easier, if only because you're dealing with larger plant, centrally located.

Time for a few final tips. First, look out for Heat Harvester, from Monodraught, known for its Windcatcher natural ventilation system. Heat Harvester, which looks like a mini jet engine, is designed for buildings with internal heights from five to 12m. According to the firm, if suspended just below the roof level, it recycles hot air by blasting it down to floor level. Evidently, a 35W motor is enough for an eight-metre ceiling, which equates to 50p per week running costs and an estimated 30% winter energy saving.

Second, it's making increasing sense to consider not just one, but several options for HVAC. Specialist building management firm BG Controls, for example, used a range of sustainable principles on its contract for the £12 million BreathingSpace rehabilitation centre BMS in Rotherham – including geothermal heating, solar hot water, and natural ventilation and cooling. For the latter, BG installed a Trend IQ BMS, which modulates low-level dampers in the undercroft. These draw air from outside the building and store it in a plenum vessel to cool. When required, the floor dampers open to allow cooled air into the building. The same system also controls two heat pumps, distributing ground heat throughout the building via under-floor pipes, all using touch-screen controls. PE