CIBSE JOURNAL

HOTEL AND LEISURE SPECIAL

HYBRID VRF AT THE STRAND PALACE HOTEL

CPD ON PRESS-FIT CARBON STEEL PIPING

SPORTING HIGHLIGHT

How Max Fordham maximised daylight to reduce energy use at the Oriam Sports Performance Centre

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User-friendly

Judges at this year's CIBSE Building Performance Awards said Max Fordham's entry for the Oriam Sports Performance Centre, in Scotland, outplayed the competition by a long way. Its focus on natural ventilation and lighting earned it the Project of the Year – Leisure accolade. On page 6, we explain how soft landings helped to fine-tune the lighting, heating and ventilation control at Heriot-Watt University's building, cutting energy use and improving the user experience.

To deliver comfort for gym users, engineers at Max Fordham have also been exploring the effectiveness of maximising air movement – rather than using lower temperatures – to cool exercise spaces. On page 10, the practice's Henry Pelly explains how the University of Portsmouth's new sports facility is allowing engineers to test this theory.

Users were the top priority at London's Strand Palace Hotel, where the engineers' challenge was to install air conditioning in 785 rooms without disturbing the guests (page 14).

Finally, our CPD module, on page 19, explores key aspects that influence the serviceable life of press-fit carbon steel piping in closed heating and cooling systems.

LIZA YOUNG, DEPUTY EDITOR lyoung@cibsejournal.com

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Giving a quality experience

Hotel guests and users of leisure facilities expect the highest quality and reliability. So building services managers of hotels, restaurants, spas and leisure developments should ensure that plumbing and pipework systems perform as intended.

For hotels, any failure in the heating or water-supply systems will not only have a detrimental effect on guests' enjoyment of their stay – which can tarnish the business's reputation – but also cost the company money in lost revenue if rooms cannot be used. So the quality and reliability of the products chosen are key considerations. Modern press-connection technology offers a simple, consistent and robust solution for constructing pipework systems with the longevity to minimise maintenance costs.

The installed performance of pipework systems is an important part of a visitor's experience. Low water pressure can be caused by several factors, such as poor system design and incorrect product specification. Every element of the system will contribute to the friction in the pipework – reducing the flow rate and, so, the water pressure.

In hotels, where the layout of the pipework can be complex, the cumulative additional resistance of potentially thousands of joints means selecting the right product is essential. For example, elbow fittings where the internal structure and deflectors have been specially designed to optimise the flow of water – and press connections, where the compression of the fitting or the sealing element does not reduce the internal bore size of the pipe and cause a 'throttling' effect.

With guests' recommendations and reviews more easily available than ever before, ensuring the performance, longevity and reliability of building systems has never been more important.

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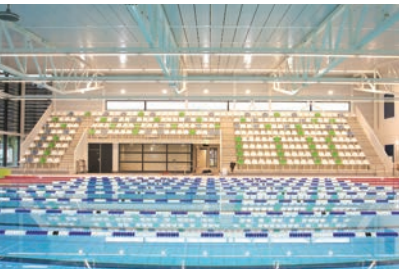

LEDs designed to last in harsh environment

To prolong lamp life and meet strict criteria for light quality, leisure centre specialist Pellikaan Construction has used Eva Optic LEDs at its new multimillion pound project in Waltham Abbey, Essex. The centre's lighting design includes 26 LED lights for ambient lighting in its swimming hall, comprising a 25m pool and 15m learner pool.

Pellikaan's Bas Sanberg said the firm's range is manufactured from materials that can withstand an aggressive pool environment, where heat, chlorine and humidity can quickly take their toll on ambient lighting and reduce lamp life expectancy.

The light body components and fixing materials are made using hot-dip galvanised metal, duplex-coated or anodised aluminium. Further protection is offered by anti-overheating technology that ensures a life of at least 50,000 hours.

To meet Sport England's criteria for light quality, the large hall's lighting delivers 320 lux on average, and a light uniformity of 0.74, with minimal glare (UGR<19).

The range benefits from a high colour rendering index of >85, which ensures skin tones look natural, according to the firm.

Sensors lead to savings in Spain

Energy consumption has been cut by 40% at the Club Mac hotel in Puerto de Alcudia, Majorca, after HVAC sensors from Sontay were installed.

The 100,000m^2 site comprises three buildings with a total of 1,024 rooms, 953 of which are twin rooms and 71 family suites, all with air conditioning.

Sirc Baleares upgraded the BMS and installed sensors to monitor sanitary hot water, air conditioning and lighting at the complex. Electrical consumption and temperatures of 40 kitchen refrigerators are also monitored.

Outdoor light-level sensors allow the lights to be dimmed or turned off if no-one is using the space, to optimise efficiency.

Wireless fire alarm protects former police headquarters

Battery-powered WES+ system complies with fire-detection standard

Galliard Homes has fitted a wireless fire alarm system to the original Scotland Yard police station in London, to protect the building while it is being transformed into a five-star hotel. The £110m development will retain the original façade of the building, which served as the Metropolitan Police HQ from 1829 to 1890.

Galliard Homes has used hard-wired fire alarm systems on previous sites, but said trailing wires created a trip hazard and it was time consuming to reposition call points (using a qualified electrician) as work progressed.

David Ridge, the company's site services manager, said that the specified Ramtech WES+ system – which is compliant with EN 54: Fire detection and fire alarm systems – would be transferred to the developers' next project. '[The system] overcame the challenges we had with hard-wired systems, and being compliant with the relevant sections of EN 54 meant we were confident that it gave us the best fire protection.

WES+ says its system has a three-year battery life, and nominated personnel at Galliard Homes will receive a text alert if any call point is activated. The interconnecting call points can be installed with button-presses and up to several thousand units can be paired. A silent test facility eliminates downtime on site.

Premier League club gets an upgrade

Contractor Lord Combustion Services has installed 11 Remeha condensing boilers at Wolverhampton Wanderers' Molineux Stadium, and the club's Sir Jack Hayward training ground in Compton.

They were fitted to achieve more reliable, more efficient heating, and to minimise operational impact, after the Premier League club's failing boilers reached the end of their serviceable life.

At the stadium, five condensing boilers were installed for space heating, alongside Andrews Water Heaters' fully condensing direct-fired water heater to meet the high demand for hot water from crowds of nearly 32,000 on match days, and for post-match showers.

At the Sir Jack Hayward training ground, six Remeha boilers were installed in a cascade arrangement, to maximise their energy-saving benefits and to allow servicing and maintenance to be carried out without disruption.

The boilers' small footprint and multiple flueing capabilities make them easy to install, claims Rehema. With individual outputs of between 34.6kW and 161.4kW, and compact dimensions, they move large outputs away from the floor and onto the wall in plantrooms with limited space.

MULTIMILLION POUND HOTEL COMPLEX BREAKS GROUND IN LEICESTER

As part of a £250m regeneration plan for the city, a 10-storey, 250-room hotel complex – for Novotel Hotels and Adagio – is taking shape in Leicester, with Pick Everard delivering mechanical and electrical engineering, structural engineering and quantity surveying services. The life-cycle of the buildings has been taken into account, with future maintenance and running costs factored in to ensure it makes as little environmental impact as possible. The design underwent thermal modelling and daylight analysis, while the acoustic elements of the individual rooms and conference facilities – with stringent noise levels – were also factored in.

Legionella discovery closes Midlands hotel

Bacteria found in water samples at Ramada Park Hall

A Wolverhampton hotel and spa was forced to close in the summer following the discovery of legionella bacteria

The Ramada Park Hall Hotel and Spa was served with a prohibition notice by Wolverhampton City Council banning the use of its hot and cold water systems until remedial works are completed.

There was no evidence of any cases of Legionnaires' disease as a result of the incident but the council took the precaution of closing the hotel to prevent the risk of anyone falling ill.

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Protecting against legionella

Tips for healthy systems by water specialists Guardian

Make ongoing maintenance a priority
Low flow fittings for taps and showers can be crucial in leisure environments that use high volumes of water; but they can allow water to stagnate, creating perfect conditions for legionella growth. To counter this, ongoing maintenance is crucial, with regular cleaning and testing for the presence of harmful bacteria.

Take a bespoke approach
Increasing the dose of chemicals does not always result in increased legionella protection. Sometimes adjusting filtration or backwash settings can result in a more efficient system.

Where chemicals are used, by tailoring dosing to a specific system and its use, excess dosing can be avoided.

Reduce chemicals and chlorine
As well as treating legionella and other pathogens, non-chemical water treatment alternatives – such as advanced oxidation technology – have a knock-on-effect of reducing the need for chlorine, in some cases by as much as two-thirds.

Get trained up
Training is key for all members of the FM team. We see many examples of supplementary treatment devices that end up failing or being turned off because of a lack of understanding of their required planned preventative maintenance regimes.

Free EV charging points for AA-inspected hotels

Around 4,000 hotels and B&Bs are being offered electric vehicle (EV) charging points at no cost by Chargemaster.

The charging company said it would work with any AA-inspected establishments that wished to take up the offer. Rapid chargers could be installed in hotels on high-traffic routes, it added, while destination chargers would be suitable for guests charging their vehicles overnight. The first charger was installed at the Sandford Springs Hotel, in Kingsclere, Hampshire.

The Chargemaster 50kW rapid charger is available for any EV driver to use on the company's Polar network.

Chargemaster, which was acquired by oil and gas giant BP in June, said its research showed that 90% of EV drivers would seek out destinations that have charging points over those that don't.

David Martell, chief executive of Chargemaster, said: 'We believe, within the next five years, all hotels will offer EV charging, just like they provide Wi-Fi today. Our offer for AA hotels is a great opportunity for hotel owners and operators to get a competitive advantage.'

Scotland's sporting great

The services design for the CIBSE award-winning Oriam Sports Performance Centre minimises energy use while maintaining optimum conditions for playing sport. Andy Pearson finds out how Max Fordham was able to maximise daylighting and natural ventilation, and – at the same time – meet strict requirements for lighting and overheating

'The key M&E design challenge was to meet the exacting environmental conditions demanded by various elite sports while minimising annual energy consumption,' says Mark Palmer, senior partner at consulting engineers Max Fordham.

Palmer is talking about Oriam Sports Performance Centre, which opened in autumn 2016 at Heriot-Watt University's Riccarton campus, west of Edinburgh. The new sports complex is a training base for Scotland's national football and rugby teams, offering state-of-the-art changing rooms, hydrotherapy pool, strength and conditioning gym, and a FIFA-accredited indoor synthetic pitch – the largest of its kind in Europe.

These facilities are also used by Heart of Midlothian FC, Hibernian FC, Edinburgh Rugby and English Premier League football teams for their pre-season training. In addition to football and rugby, Oriam is used as the training home of Scotland's national governing bodies for basketball, handball, squash, racketball and volleyball. Oriam was designed to offer an inspirational environment for all levels of sporting activity, including the local community, university students and top international athletes.

Max Fordham developed the centre's design with Reiach and Hall Architects. With so many sports housed in the one complex, flexibility and adaptability of environments was key to the low-energy building services design. Instrumental in achieving this aim was the use of soft landings, which was applied to all stages of the project – from

BPA 2019

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the briefing with the campus estates team, the operations team and the various sports' governing bodies through to the design development, commissioning, handover and aftercare.

'The spaces had to accommodate many different sports at all levels. The main sports hall also had to be capable of being adapted to cater for large-occupancy events, such as graduation ceremonies for 850 people,' explains Palmer.

The new building was designed to link with existing facilities on the campus to form a large, integrated sports complex. Conditioned sports accommodation and associated offices are arranged on either side of the indoor synthetic pitch, with high-performance facilities on the south side linking with the existing Hearts FC academy, and the nine-court sports hall, fitness suite and café on the north side joining up with the existing sports centre. The main indoor pitch can be accessed from changing facilities on both sides.

This synthetic pitch is sheltered from the weather by a giant, arching, translucent roof, held aloft on steel trusses spanning 80m and rising 29m at the centre of the arch. The space is designed to be subdivided for use by multiple teams or activities.

Although the sports facilities are used by Scotland's top athletes, it was important to ensure they also cater for recreational sports, the local community and students on campus.

'Our challenge was to deliver these high-performance environments with the lowest possible energy consumption,' says Palmer.

'To achieve this, we must first recognise that sports buildings have highly irregular use patterns, occupancies and activity – and the heating, cooling, ventilation and lighting must be set up to respond accordingly. We must also take advantage of the free heat, light and fresh air in the natural external environment whenever possible.

'All too often, sports facilities are built as black boxes, with artificial conditioning set to operate at full capacity for more than 15 hours a day, irrespective of the occupancy and activity.'

Oriam has some huge indoor spaces, with very long hours of operation (6.30am to 10pm) which, at times, require very high levels of illumination. 'Without good quality daylight and fine-tuned lighting control, the installed lighting at Oriam has the potential to consume more than £100,000 of electricity per year – this scenario is not uncommon in typical sports buildings,' says Palmer.

At Oriam, the lighting loads have been reduced by 75% compared with a typical »

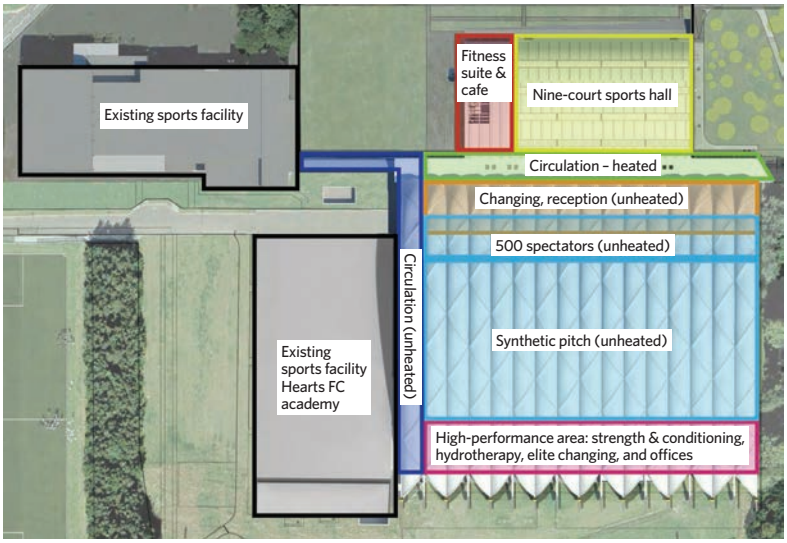
Credit / Ioana Marinescu

DECLARATION OF PERFORMANCE

In Scotland, Display Energy Certificates (DECs) are not mandatory for public buildings, but draft versions of the certificate have been produced to benchmark Oriam sport centre's performance.

The vast area associated with the indoor synthetic pitch tends to distort the DEC rating, delivering DEC A quite comfortably. 'Rather than sit back and congratulate ourselves on a job well done, we decided to calculate a second DEC rating, this time with the synthetic pitch area excluded,' says Palmer.

This overall building area reduction resulted in an increased energy consumption per m^2, giving a notional rating of DEC C. 'In truth, we think the building probably performs somewhere in between these ratings, which is very good for the first year of occupation,' he says. 'We would expect the second-year DEC to be even better as a result of the changes we have made over the first year.'



Credit / Ioana Marinescu

» black-box sports building, by ensuring that the lights are switched off when the daylight is available, and set to suit the occupancy and sport being played in each zone.

'Lighting is where the biggest wins can be had,' Palmer explains. 'This may sound easy, but often proves very difficult to achieve in practice. It requires a lot of commitment and collaboration from the client, contractor and design team to get the daylight right and then iteratively identify, investigate and fine-tune the control interfaces and settings.'

Accordingly, Max Fordham set out to develop a design to maximise the use of daylight and natural ventilation. 'Daylight in sports buildings is good to reduce lighting energy and create a more inspiring space, but it must be carefully designed to control unwanted glare and prevent overheating in summer,' Palmer says.

A key challenge in developing the daylight design was to meet the exacting light-level requirements demanded by the various sports bodies without glare. Modelling was used extensively to ensure the design worked. For example, the synthetic pitch uses translucent cladding and roofing materials, which mean that – for most of the year – no artificial lighting is required during daylight hours.

'The membrane's transparency has been tuned to control solar gain while delivering a daylight factor of 6%, sufficient to play sport without artificial lighting for the majority of the year,' explains Palmer.

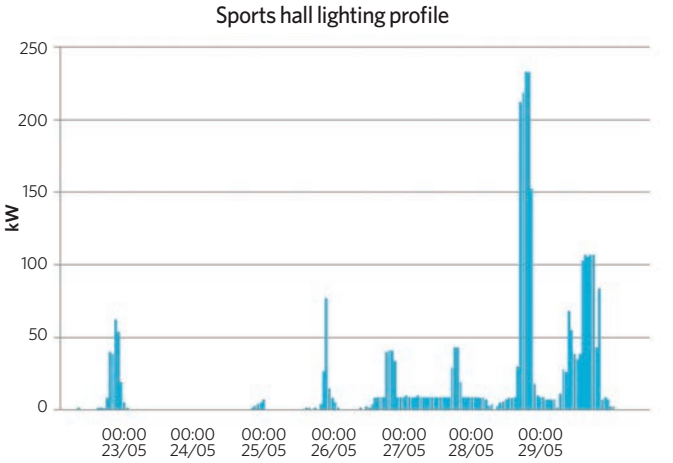
Lighting controls allow artificial light levels to be easily managed between 250 lux for training purposes and 500 lux for high-profile matches. 'An intuitive controls interface was developed as part of the soft landings process,' says Palmer.

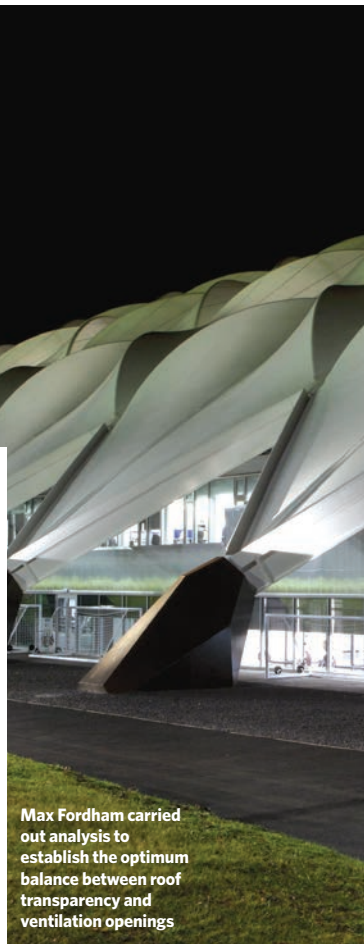
To ensure the space could operate successfully without mechanical heating or cooling, Max Fordham carried out analysis to establish the optimum balance between roof transparency and ventilation openings to avoid summer overheating. Ventilation openings have been integrated into the building envelope: high-level vents are incorporated into the gables, while lower-level vents run the length of the sides, at the roof junction with the walls.

The main sports hall has also been designed to exploit daylight. It incorporates four lines of rooflights running the length of its arched roof. These are fitted with diffusing glass, which gives sufficient daylight to allow the artificial lighting to be switched off during daylight hours while controlling glare for occupants.

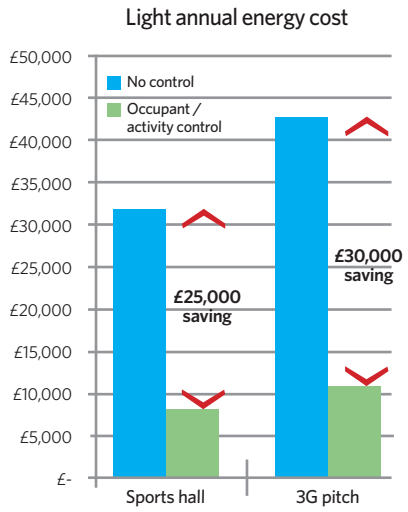
PROJECT TEAM

Architect: Reiach and Hall Architects
Client: Heriot-Watt University, The City of Edinburgh Council and Sport Scotland
M&E engineer: Max Fordham
Structural engineer: Engenuiti
Main contractor: Bowmer & Kirkland
QS: Deloitte/Thomas & Adamson





Max Fordham carried out analysis to establish the optimum balance between roof transparency and ventilation openings



Daylighting and fine-tuned control reduce the electrical load for lighting in the main spaces by £70,000 per year

'Instead of a traditional black-box indoor sports hall, we persuaded the client to opt for a naturally daylit hall to save energy and create a more pleasant environment,' says Palmer.

The hall's artificial lighting is controlled to suit the level of sporting activity and to illuminate separately each of the three zones when dividing nets are deployed. 'Initially, the Sport Scotland brief required a lighting level of 1,500 lux for the sports hall, which was beyond the CIBSE recommendations for any of the proposed sports,' says Palmer.

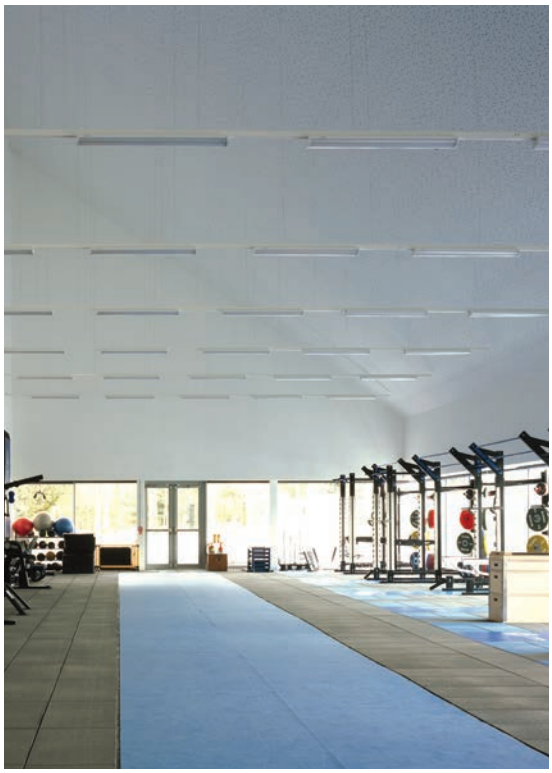
'Our first energy-saving intervention was to negotiate this down to a peak installed level of 1,000 lux [for national level volleyball], with controls to facilitate lower light levels for other levels of play – 200 lux for training and 500 lux for regional matches,' Palmer says.

In line with CIBSE guidelines, the actual lux level will also vary depending on the sporting activity. 'Our energy monitoring has shown that the combination of daylighting, fine-tuned lighting control and the reduction in the peak light level has reduced the electrical load for lighting in the two main spaces by £70,000 per year,' Palmer adds (see graph above).

The rooflights open under automatic actuator control, linked to temperature and CO_2 levels in the hall. This enables the space to be naturally ventilated and to supply adequate ventilation for up to 850 people during graduation ceremonies.

'We also carried out thermal comfort analysis to establish the peak summertime temperatures. This concluded that only in extreme summer conditions would cooling be required. For these infrequent occurrences, we developed a design strategy that would facilitate the installation of rented,

Credit / Ioana Marinescu



Credit / Ioana Marinescu

Credit / Ioana Marinescu

More than 40m² of opening rooflights control summertime overheating

"A key challenge in the daylight design was to meet the exacting light-level requirements demanded by various sports bodies without glare"

temporary cooling plant for graduation ceremonies,' says Palmer.

The soft landings process was instrumental in fine-tuning the lighting, heating and ventilation control within the sports hall, to maximise comfort and reduce energy consumption. The sports hall lighting profile graph (on page 8) for a typical week in April shows that, in general, the sports hall lighting has been switched off, or is on very low, most days. 'This means there is often sufficient daylight available and that the staff are using the controls effectively, turning the lights on at a low level and only for the required zones,' says Palmer.

The fitness suite and first-floor dining area are also daylit through full-length windows along the side wall and a translucent polycarbonate end wall. Even the high-performance changing rooms have natural light from clerestory windows.

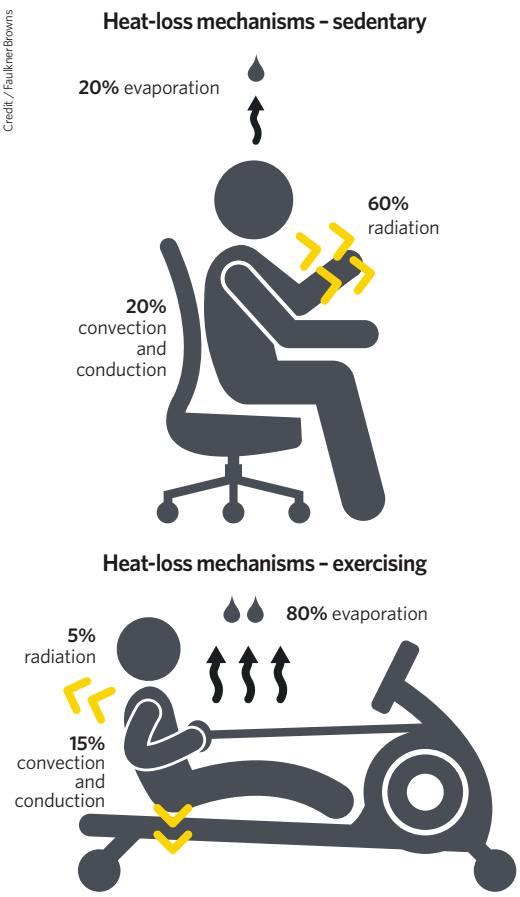
The fitness suite was designed for high levels of occupancy, so the mechanical ventilation system is designed for a high ventilation rate. To minimise energy consumption, fresh air is controlled on CO_2 to match the variable occupancy. A variable refrigerant flow (VRF) air conditioning system linked to an air-source heat pump cools the space via fan coil units. The VRF system is designed to transfer waste heat from the fitness suite to heat the café above.

The underfloor heating in the sports hall, changing rooms, corridors and reception was originally designed to be served from a ground-source heat pump. However, budget constraints required the design to change to low-NO_x gas-fired boilers. After one year of operation, total gas consumption was significantly less than had been predicted. 'This is primarily because the showers are not being used as much as expected, with so many students preferring to shower back in their halls of residence on campus,' explains Palmer.

By contrast, electricity use was found to be more than had been predicted, possibly because unregulated loads from computers and gym equipment were higher than expected. Consumption is, however, expected to drop as the result of soft landings and the fine-tuning of controls and plant operation. For example, the over-door heater was found to be running 24/7 and the sports hall set-points were too high.

Minor tweaks aside, this high-performance sports building succeeds in delivering a wide range of environmental conditions with minimal environmental impact. The building form and materials have been developed to offer extensive natural ventilation and daylighting to reduce the need for mechanical cooling, fan energy and artificial lighting. Perhaps unsurprisingly, the scheme won the Project of the Year – Leisure category at this year's CIBSE Building Performance Awards – a worthy winner. **CJ**

Credit / FaulknerBrowns



Human heat loss during different activities

Fit for purpose

Current design guidance for fitness spaces is not always optimised for comfort, according to Max Fordham's Henry Pelly, who says people exercising keep cool more effectively when air movement is maximised

In a quest to deliver comfort for active occupants of fitness suites, very low temperature set points are often prescribed as a simple way to help people lose heat.

Sport England design guidance[1] suggests 16-18°C. However, supplying active cooling to deliver these temperatures can result in very high energy use, and, as this article will explain, it often fails to deliver comfort for the occupants.

To explain the shortcomings of using lower air temperatures to cool exercise space, it is necessary to look at physiology and human heat loss.

Engineers at Max Fordham have been exploring the topic for some time. I was aware of the issue while training for the University Boat Race when I was studying environmental design.

The University of Portsmouth's new sports facility designed by FaulknerBrowns Architects gave Max Fordham's engineers an opportunity to explore ways of improving comfort. Targeting Breeam Outstanding and exemplary operational energy performance, this project is also following BSRIA Soft Landings.

The theory

When we exercise, the body's heat-exchange mechanisms are different from when we are sedentary, yet this is not reflected in current design guidance for fitness spaces. When we are sedentary, radiation is the primary mechanism of heat exchange, but as exercise intensity increases, convection, and then evaporation, become the dominant modes of heat loss.

Convective and evaporative heat transfer are both significantly increased by air movement. At lower-to-medium exercise intensities, convective heat transfer is significant. Evaporative heat loss by sweating doesn't occur until sensible heat-loss opportunities afforded by convection and radiation become ineffective – perspiring is a physiological response to inadequate sensible heat transfer.

Once this occurs, the body's only mechanism for further heat loss is increased sweat production. The effectiveness of this mechanism is limited by the surrounding air's relative humidity and velocity.

Maximising air movement should be a priority for the environmental design of fitness spaces, as it boosts our ability to use heat through convection and evaporation. Cooling a space doesn't maximise evaporation as it raises the relative humidity. The higher the temperature, the more water the air can carry. Lowering the air temperature reduces the amount of water that can be absorbed. The more humid the air, the less sweat can be absorbed, and the more uncomfortable exercise becomes.

Simple dehumidification of the space is energy intensive as a lot of moisture is released into the air as people exercise. Maximising movement of air is the least energy intensive way of maximising evaporation as well as convection.

At the University of Portsmouth, Max Fordham and FaulknerBrowns have designed the fitness suite to maximise evaporation and convection by generating air movement through large ceiling fans with four-pipe fan coils integrated into a timber-slatted ceiling. This saves energy, as well as improving comfort.

Through the aftercare period, Max Fordham will assist the University of Portsmouth in establishing the optimum set points for cooling and air movement. This will improve occupant comfort while reducing air conditioning loads.

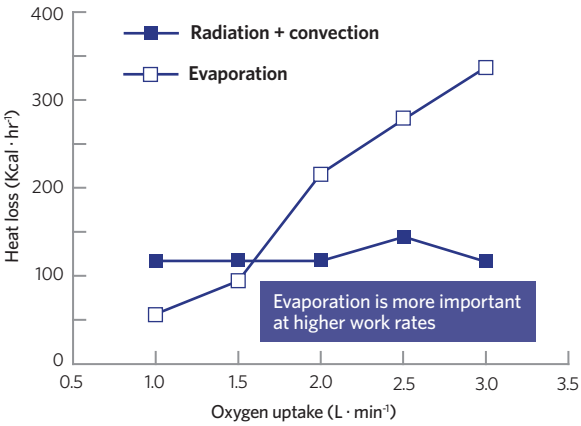
We estimate that increasing air movement in fitness suites, as opposed to relying on a lower temperature set point, will result in a 10% reduction in energy use in peak summer conditions.

We believe that designing a fitness suite to maximise convective and evaporative heat loss, will result in an ambient temperature that optimises comfort for a range of exercise intensities. Sedentary users will be more comfortable too, as relative humidity will be 20% lower than in the cooler regime and the higher set point will make it warmer.

The higher air speed will have the strongest cooling effect on those who are perspiring the most. So, an exercise space set up to maximise convection and evaporation will offer the biggest cooling effect to the people who need it most.

The project will have two years of post-occupancy evaluation and aftercare. This will allow us to fine-tune the fitness suite regime to obtain the best balance between comfort and energy reduction. **CJ**

Importance of evaporation as heat-loss mechanism in heavy exercise



HENRY PELLY is a sustainability consultant at Max Fordham

References:

1 *Sport England Design Guidance Note for Fitness and Exercise Spaces* March 2008 Revision 002, Table 5.0 Building Services Environmental Requirements

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Room service

The Strand Palace Hotel in London is having air conditioning installed in 785 guest rooms – but, with occupancy rates of 87%, the owners are keen to keep disruption to a minimum. Alex Smith looks at the Hybrid VRF system specified by Elementa Consulting

With 785 guest rooms, the Strand Palace Hotel is one of the biggest in London's West End, and its location in booming theatreland means it has an impressive 87% occupancy rate – compared with a 2017 London average of 83%.

This was a key factor in determining the strategy for a major refurbishment of services that started in 2017 and is expected to be completed in 2020. Owners London and Regional Properties needed a solution that kept as many hotel rooms available as possible during the improvement work. The aim of the refurbishment was to install more efficient services while supplying every guest bedroom with air conditioning.

Before the refurbishment, heating and hot water were supplied by four gas-fired boilers. Cooling was limited to 37 rooms, each of which had variable refrigerant flow (VRF) air conditioning units installed in a previous facelift. Openable windows offer some cooling and ventilation, but the hotel's proximity to the busy Strand – and its pollution and noise – means they cannot be relied upon in south-facing rooms.

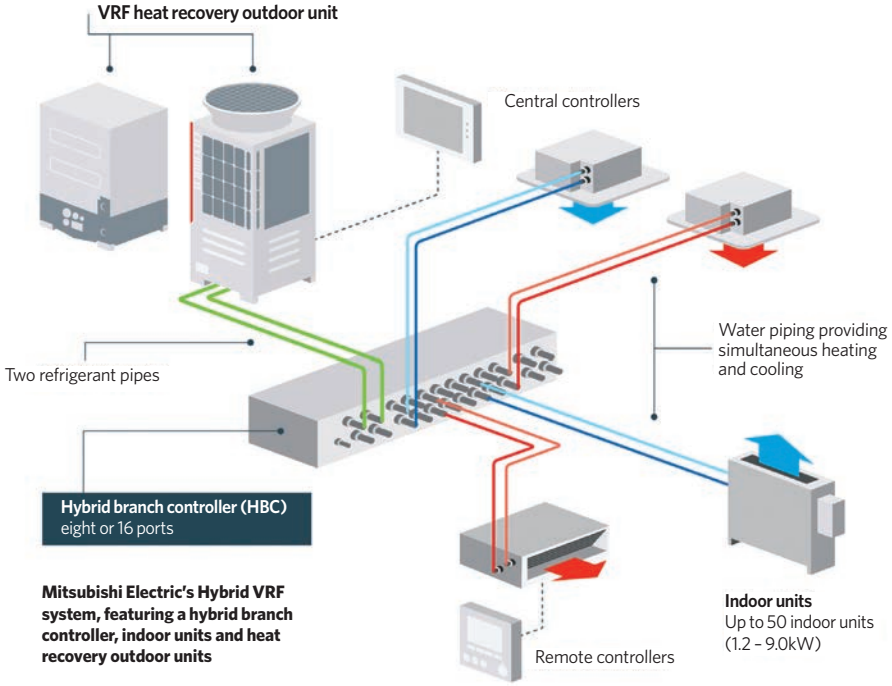
Elementa Consulting was asked to design the new services, which were installed by Working Environments and their appointed design and build consultant PSH Consulting. The requirement for cooling, the lack of available plant space, and the need to minimise disruption led the team to choose a Hybrid VRF system from Mitsubishi Electric, for the cooling and heating of guest rooms.

It was calculated that the carbon emissions associated with space heating would be three times lower with the Hybrid VRF system compared with the existing gas boiler system.

'The hotel has to stay operational during the refit and the Hybrid VRF system suited a phased install,' says Ted Connell, mechanical engineer at Elementa Consulting. To minimise disruption and loss of revenue, the plan was to refurbish guest rooms one floor at a time, from the ninth floor downwards.

'It was not economical to have more than two chillers, so you couldn't have a chiller on each floor, which would avoid disruption when installing one floor at a time. Bigger risers would also be required for the larger pipes,' says Connell.

Hybrid VRF allows simultaneous heating and cooling with heat recovery, and requires smaller plantrooms than a traditional chiller system. The 'hybrid' prefix refers to the use of both refrigerant and water to deliver cooling and heating to the indoor units. Rather than having large plate heat exchangers in a big chiller to provide cooling and heating, the Hybrid VRF system uses a network of paired plate heat exchangers in much smaller containers, known as hybrid branch controllers (HBCs). (See panel, 'How Hybrid VRF works').



Mitsubishi Electric's Hybrid VRF system, featuring a hybrid branch controller, indoor units and heat recovery outdoor units

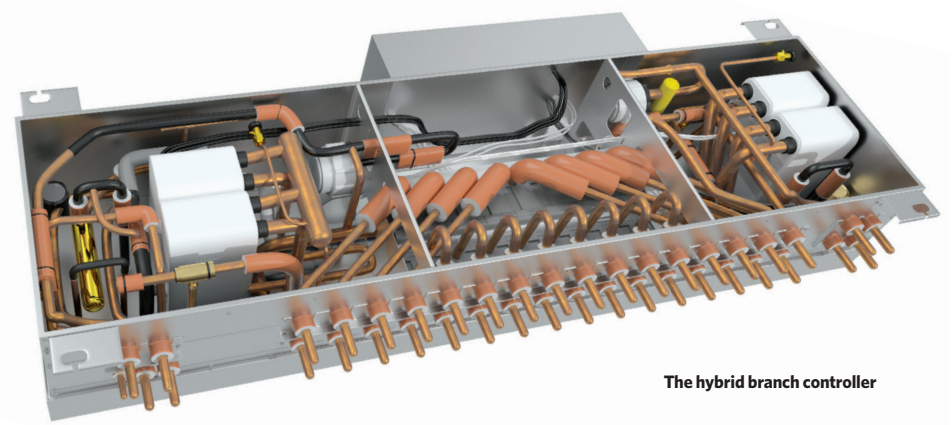
The HBCs at the hotel have 16 pairs of ports (for hot and cold water) and, on average, 14 rooms are connected to each. There are 99 to 101 guest rooms on each floor, so space had to be found for six to seven HBCs on each level. Their small size meant they could be suspended from ceilings, like traditional VRF branch controller boxes, and they were installed in existing small spaces such as linen cupboards.

Each HBC is connected to an outdoor condensing unit. For the nine floors of rooms, around 60 units are required (one outdoor unit can serve up to 50 indoor units). Despite the large number, their small footprint relative to a chiller means it will be possible to locate them all on the hotel's roof, says Connell. 'There was no physical space for a chiller on the roof and the point loadings of the chiller would have been too large for the structure. It made sense to use smaller VRF condensers, and we will be able to install them in repurposed plantrooms.'

Mitsubishi Electric's Jobin Varghese says a key benefit of Hybrid VRF is that water, rather than refrigerant, enters pipework in the guest rooms, which means there is a saving on refrigerant and no need for leak-detection equipment. So the hotel saves on the cost of wiring and maintaining such equipment, as well as the expense of having to calibrate the sensors every year.

Varghese also claims it is simpler to commission a Hybrid VRF than a chiller when ensuring there is no air and debris in the system. 'With chillers, commissioning engineers have to balance the flow rates of every indoor unit or radiator and manually take out the air,' he says.

In a Hybrid VRF system, the engineer controls a switch on the HBC, which pumps water through the pipework and pushes air through an automatic air vent. Any debris in the system is collected in a strainer in the HBC, which can be removed and cleaned. It takes 10 minutes per indoor unit for the flow rate to stabilise and air to be released.



The hybrid branch controller

HOW HYBRID VRF WORKS

Refrigerant flows between outdoor condensing units and a metal box known as a hybrid branch controller (HBC), which contains two plate heat exchangers. These transfer heat and coolth to closed water loops between the HBC and indoor fan coil units in the guest rooms. DC inverter-driven water pumps and a valve block in the HBC control the flow of water to the rooms. The heat exchangers are at opposite ends of the HBC box, and supplies hot water in heating mode and cold water in cooling mode. In mixed operation, one heat exchanger provides hot water, while the other provides cold to the respective flow header. Each HBC has flow and return connections for 16 indoor units.

Another advantage of the system, says Varghese, is that – if there is a problem with an indoor unit valve – it can be isolated and swapped out of the valve block in the HBO.

The Hybrid VRF is sold by Mitsubishi Electric as a system, which means there is less potential for it to be incorrectly specified and there is a single warranty. 'We provide all the components and advise you what size and pipe lengths to use, how to install and commission it, and what controls to use. It's easy and straightforward,' says Varghese.

The control panels, designed by Mitsubishi Electric, show temperatures in every guest room. There is an option to connect these to a hotel key-card entry system, so that indoor units are automatically set back to 18°C if there is no-one in the room.

The Strand Palace Hotel does not have this option currently. Instead, cleaners set the temperature whenever they go in the room and the occupants are not there.

Temperatures for all the rooms can be set from the control panels, which eventually will be linked to a remote monitoring system. This will be particularly useful for some guests, says David Abercrombie, the hotel's chief engineer. 'We have professional dancers staying and chaperones insist we set their room temperature at 21°C so they have ideal conditions before going on stage.'

So far, the project team has installed Hybrid VRF on the top three floors. The ground floor, containing the lobby and restaurants, will be the last to be refurbished. DX split units currently serve this area, but Connell says they will probably move to a centralised system.

Elementa have also analysed data from the occupied hotel to measure water use. 'This will be greatly reduced by the refurbishment, further reducing boiler load,' says Connell.

PRODUCTS & SERVICES

Adveco Totem: Ultra-low NO_x CHP

The Adveco Totem m-CHP range offers cogeneration efficiencies and the lowest carbon and NO_x emissions available from any CHP within its class at <12 mg/kWh, making it one of the greenest micro-cogeneration solutions on the UK market. Such low emission levels mean the Totem range is eligible for full Breeam credits under the revised (2018) POL02 criteria, even within Air Quality Management Areas, and is 95% lower than the 2018 Ecodesign standards for clean CHP at 240 mg/kWh.

A Totem T25 CHP was recently installed at a state-of-the-art leisure centre in Bromsgrove as part of the building's heating system, alongside a bespoke buffer vessel and high-efficiency condensing water heaters. Commissioned by Adveco, the CHP is on track to achieving its design estimate of 7,000 operational hours per year, giving annual savings as high as £10,000, and net carbon emission reductions in excess of 65,000 kg.

Visit www.adveco.co/chp/

Mikrofill at club 3000 Bristol

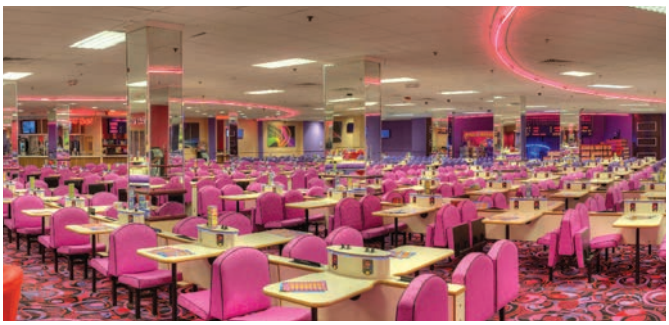
With a dozen clubs nationwide, Club 3000 Bingo in Bristol is the latest branch to benefit from a plantroom overhaul.

The existing inefficient equipment was removed from site to make way for four frame-mounted Ethos 130kW condensing boilers. With a combined modulation of 40 to 1, and NO_x levels as low as 33mg/kwh, the new stainless steel boilers provide CT LPHW to air handling units and a VT circuit to radiators throughout the building.

The boilers integral shunt pumps are set to operate at a Δt of 20°C directing LPHW to a Mikrovent 750 low loss header/air and dirt separator capable of filtering sediment as small as 5 microns. Designed and installed by long-established mechanical contractor William Austin Engineering, the equipment was delivered to site to meet the project's tight schedule. The plant package has full remote BMS compatibility, incorporating weather compensation.

In addition to the boilers, the new LTHW system was unvented with a pre-commissioned pressurisation package incorporating the wall-mounted Mikrofill 3, a 600-litre expansion vessel and service drain valve.

Call 03452 606020 or visit www.mikrofill.com



A Welcombe boiler replacement

The Welcombe in Stratford-upon-Avon is one of Hallmark's many prestigious hotels in the UK. Set among 157 acres of landscaped grounds with access to its own spa and golf course, it presents a relaxing retreat for its guests and day members. Like many hotels, the Welcombe was facing the issue of old boilers becoming unreliable, nearing the end of their serviceable life, with spare parts being difficult to source. Over two years, Danny Bulch, director at Cedar Green Projects, replaced the boilers, gas-fired water heaters and calorifiers in the hotel, spa and golf club with varying products from the Hamworthy range. The products were chosen because of their ability to suit a range of applications and overcome the main challenges of the project: refurbishing a hotel during peak heat requirements in winter, overcoming access issues to the plant room and accommodating different fuel options.

The Welcombe spa offers an indoor and outdoor pool, treatments and a fully equipped gym. Five large cast-iron boilers with a combined output of approximately 500kW supplied heating and hot water to the spa. As boilers kept splitting and were becoming unreliable, a replacement was needed. Bulch chose three Hamworthy Purewell VariHeat cast-iron floor-standing condensing boilers with a combined output of 540kW to substitute the five old boilers. They are the only ErP-compliant cast iron condensing boilers in the UK.

Bulch said: 'Hamworthy's Purewells are compact and sturdy cast-iron boilers with large waterways, we use them in our temporary boiler rooms for this very reason. Looking at the requirements of the spa, there wasn't a moment of hesitation in choosing these boilers as we know them so well.'

To accommodate the hot-water requirements, PS200 and PS500 Powerstock calorifiers were chosen. These glass-lined indirectly heated water heaters supply a combined hot-water output of up to 2,149 litres per hour at 50 degrees differential temperature. They also benefit from a recovery time of only 20 and 18 minutes respectively.

Two large atmospheric boilers on a fan-dilution system previously delivered heating and hot water to the main building of the hotel. One of the boilers suffered from a split heat exchanger, which meant the second boiler was the only one left working. Bulch opted for Hamworthy's Wessex ModuMax mk3 196/588V, a small modular condensing boiler with stainless-steel heat exchanger that has a 10-year warranty, to replace the old boilers. The model can deliver an output up to 588kW from less than a square metre of footprint and consists of three individual boiler modules that can be flexibly stacked on top of each other to suit difficult plant room layouts. The boiler can efficiently match the heat load from 39kW incrementally all the way up to 588kW. This is possible thanks to the 5-to-1 turndown ratio per module, combined in a three-high stack, it then becomes 15 to 1. The higher the number of modules, the higher the turndown ratio of the system.

Call 01202 662500 or visit www.hamworthy-heating.com

Rehau supplies portfolio of pipework solutions to help deliver district heating programme at Piperdam

Rehau is helping to deliver a district heating programme at Piperdam – a luxury resort situated on the banks of Loch Piperdam, near Dundee. The award-winning resort is set in 650 acres of Angus countryside. Located just 10 minutes from Dundee and 20 minutes from Perth, the resort has a number of self-catering lodges as well as restaurant and leisure facilities on site.

Six years ago, Piperdam's owners collaborated with a local installation company – Hydroscot Energies – on an energy strategy for the resort. Piperdam is off the mains gas grid and was reliant on expensive alternative fuels, such as LPG and kerosene, so the owners were keen to find more sustainable and cost-efficient methods of heating the tens of holiday lodges located on the site.

Scott Gaffney, owner of Hydroscot Energies, said: 'Piperdam has more than 80 holiday lodges, some privately owned and some available for holiday lets, all with a requirement for space heating. To meet this demand in the most cost-effective and sustainable way, we looked into various forms of renewable energy systems, but the most suited to the project was a series of district heating networks powered by several large biomass boilers in conjunction with a biogas combined heat and power plant (CHP).'

Hydroscot Energies recommended a phased programme of installations, starting with three networks to provide heating for 70 holiday lodges. Each network would be powered by a biomass boiler ranging between 200kW to 1MW. The main commercial complex complete with swimming pool, spa, gym, restaurants and bars was powered by the CHP.

To transfer the heat from the plant rooms to the lodges, Gaffney required pre-insulated pipework. As the lodges are spread across a large area, the pipe runs necessary were quite considerable in places, so he needed a product that would minimise heat losses as much as possible to ensure the efficiency of the system was upheld. Gaffney got in touch with Rehau about its pre-insulated pipe range. He found Rehau was the only one with a UK base, which he felt was critical to the smooth running of the installation programme.

Gaffney said: 'Our Rehau regional sales representative ensured we had a good supply at our local wholesalers, plus he was on hand to answer any questions or queries we had, which was really useful as we hadn't worked with Rehau products before.'

Gaffney specified Rauthermex and Rauvitherm pipework for the Piperdam job. Rauthermex is a PE-Xa pipe suitable for a variety of low carbon heat installations and featuring high performance PU foam.

Visit https://www.rehau.com/gb-en

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Effective use of corrosion-resistant press-fit carbon steel piping systems

This module explores some of the key aspects that influence the serviceable life of press-fit carbon steel piping in closed heating and cooling systems

Carbon-steel pipework has been applied in building services systems for almost 200 years. If employed in an appropriate application – and maintained properly – such pipework systems are set for a long and productive life. Press-fit systems, which have been commercially available for more than 50 years, can provide a speedier install time than the traditional jointing methods (such as screwing or welding) and do not require any hot works or screw cutting. As with all building services systems, the longevity and effectiveness of a carbon-steel pipework press-fit system will be dependent on proper installation, operation and maintenance, and this article will consider some of the key aspects that influence the serviceable life of such a system.

Corrosion in pipework

Pipework corrosion will be caused by oxygen in the presence of water and can be accelerated through galvanic action. If the water contains dissolved salt or is acidic (that would include acid rain), then corrosion will be exacerbated.

Carbon steel and stainless steel contain iron, which, in the presence of oxygen – in both water and ambient air – oxidises, creating rust. The added chromium in stainless steel makes it more corrosion-resistant than carbon steel by producing a thin passive layer of oxide on the surface that prevents further corrosion. Carbon steel does not typically have enough chromium to form this chromium oxide layer, allowing oxygen to bond with the iron, resulting in iron oxide, or rust. However, the cost of billets of stainless steel is approximately five times that of carbon steel, so the use of stainless pipework is typically restricted to specific applications, such as drinking water services or for hygiene-controlled areas.

A galvanic cell results when two physically connected dissimilar metals are placed in an electrolyte (such as water). Figure 1 shows the electrode potential of metals when in seawater. The potential difference between two metals is the driving force for an accelerated attack on the anode metal, which dissolves into the electrolyte. Metals that are more anodic (towards the top of the chart) will corrode more easily and the metals that are more electronegative – or cathodic – are more resistant to corrosion.

An electrolyte is a solution that contains ions so that it will conduct electricity. Pure water is a weak electrolyte and a very poor conductor, whereas seawater – which contains almost 4% common salt – is a »

STEEL

Steel is an alloy made from iron and carbon. The percentage by weight of carbon determines the potential strength and ductility of the steel. Other elements, such as tungsten, chromium, cobalt, manganese and molybdenum may also be used as alloys, but in the standards that define 'carbon steel', that is also known as 'mild steel'; the amount of carbon is the key factor, and the amounts of other alloying elements are not specifically defined. As the carbon percentage content rises, steel becomes harder and stronger (with heat treatment), but it also becomes less ductile. Steel with a higher carbon content is less suitable for welding, as the higher carbon content lowers the melting point. Carbon steel for HVAC pipework is typically 'low carbon' steel that contains up to 0.3% carbon.

Stainless steel is iron alloyed with a minimum of 10% chromium as well as smaller amounts of other alloys.

strong electrolyte. As explained more fully by Sperko,[1] the fluid conductivity heavily influences the overall corrosion rate. Condensation that collects on the outside surface of a chilled water line inside a building is typically a comparatively low conductivity fluid, so the corrosion rate caused by condensation on the outer surface of an unprotected metal couple in such a pipe will be low. That same condensate on an outdoor pipe in an industrial or coastal environment will be contaminated with salt or chemicals and become highly conductive; not only will a couple corrode at a greater rate, but also the pipe will rust. The farther apart the two metals are on the chart, the greater the reaction to cause corrosion in the more active metal.

Metals close to each other on the scale are safer to use together. The grey bars are the 'normal' state of the metal, while the blue lines are where a metal is 'active'. An 'active' variant of a metal shifts position on the galvanic scale, making it more anodic. So, for example, carbon-steel systems with a high proportion of copper can lead to increased galvanic corrosion. As carbon steel is more anodic, the corrosion will be seen here instead of on the copper. However, substituting carbon steel for other materials, such as grade 316 stainless steel, can move the potential problems to a different part of the system. In a system made from mild steel, any free oxygen from the initial fill water is quickly absorbed (as corrosion) into the steel. Removing carbon steel from the pipe system means that the oxygen will react elsewhere.

Thin-wall welded steel piping and press-fittings

Welded pipe is formed by rolling carbon-steel strips through a series of grooved rollers that mould it into a circular shape. The ring of pipe is then passed alongside welding devices that complete the seam. Welded pipe is cheaper than extruded pipe, but its inherent strength is formally taken as being about 20% less (as required by standards). There is little else to choose between modern, good quality welded pipe and extruded pipe, since a quality controlled welded production will effectively produce a completely homogenous tube. Poorer quality tubing can suffer from poor bead removal and finishing (causing dimensional irregularities), as well as pitted seams or inappropriate fill materials that exacerbate risks of corrosion.

Carbon-steel pipes are available in many wall thicknesses at the various nominal sizes. Those with a thinner wall thickness

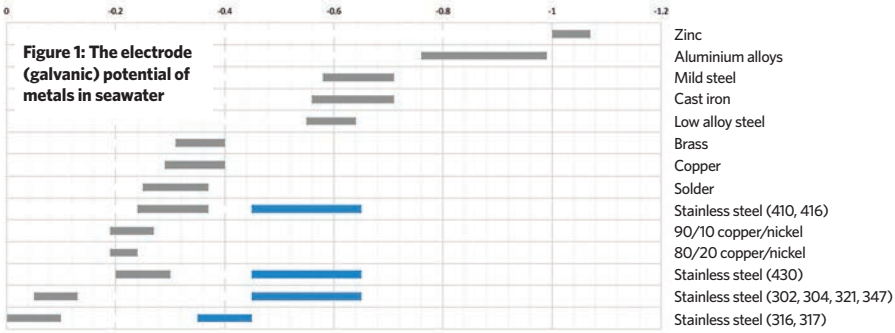

Figure 1: The electrode (galvanic) potential of metals in seawater

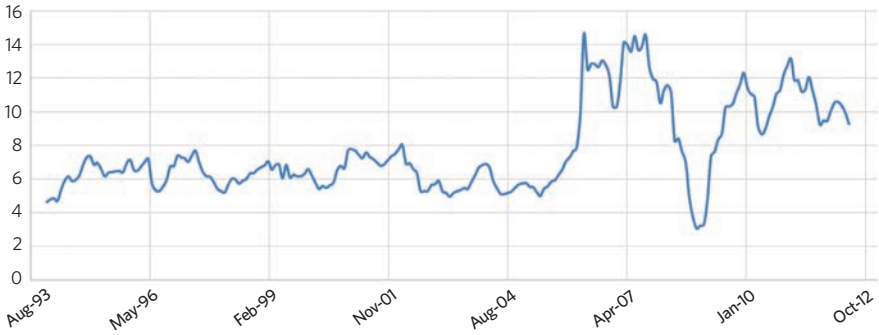

Figure 2: The relative price of copper compared with steel (price of copper divided by steel)

provide lightweight systems that employ less material and are easier to install but, since there is less material in the pipes' structure, can be more readily perforated where they are not installed or operated appropriately (through corrosion or other physical damage). Such thin-wall pipe – which has a wall thickness of about half that of EN 10255[2] type L2 'light' pipe – is often joined using roll-grooved or press-fit type fittings that maintain a water seal using captured O-rings. Thin-wall pipe is available with external and internal zinc coatings (created through electroplating), which prevent corrosion of the steel by forming a barrier and acting as a sacrificial anode if that barrier is damaged. (See Sperko's article[1] for more details on protective coatings.) Thin-wall piping is also available with external polypropylene coating to prevent corrosion from ambient moisture and oxygen.

The press-fitting jointing system was initially developed in the 1950s for copper pipes, but it was slow to gain initial acceptance as, reportedly, the trade was reluctant to trust a method of connection that did not involve heat. However, a commercial product was established in the late 1960s, and systems were developed to use with copper, carbon-steel and stainless-steel pipes.

Examples of low carbon steel press-fittings (Source: Geberit)

As shown in Figure 2, copper prices increased sharply in 2006 compared with those of steel. Those who had already become experienced in specifying and employing press-fittings on copper pipe (particularly in northern Europe) provided a keen base to use similarly speedy methods with thin-wall carbon-steel pipework. However, unlike copper, there is a more immediate risk of corrosion in steel pipework systems when they are not installed and operated with appropriate care.

Installation and operation of thin-wall carbon-steel pipework systems

Information on how to handle, install and operate thin-wall carbon-steel systems is (and was) readily available from both manufacturers and in industry standard guidelines. But the lack of experiential knowledge meant application and design have not always taken this into consideration. In the post-recession marketplace, carbon-steel sales continued to grow as the industry recovered and businesses re-established. Reportedly, the material was applied inappropriately – being installed outside buildings, in open systems and with excessive water treatment.

An infamous example of the problems arising from inappropriate application is the critical care building at Royal Victoria Hospital in Belfast, Northern Ireland, which was set to open at end of the 2012. Following the £150m investment, reports[3] indicated that corroded pipes had delayed the construction project and contractors had to rectify the problem. This led to suspension of the project (the building is still not in full use) and added significant costs – as well as publicising a high-profile 'failure' of the 'new' press-fitting technology.

The ensuing bad publicity effectively caused a hiatus in the application of press-fit thin-wall carbon steel in Northern Ireland. However, less than two miles away from the problems at the Royal Victoria Hospital, a 12-year-old press-fit installation was inspected at the Mater Hospital. Here, in comparison, all samples of the polypropylene-coated thin-wall carbon pipework installation were found to be corrosion free, as illustrated in the sample in Figure 3.

Thin-wall carbon-steel pipework should only be used in closed water systems with closed expansion tanks and appropriate venting – it should not be employed where it is unprotected and so exposed to weather. In a closed system, the free oxygen in the initial fill of water will be used up in initial light rusting on the internal surfaces and, as long as that water is not replaced, there should be no source of additional free oxygen. As discussed by Munn,[4] there are three main ways oxygen can enter a closed water system:

- From aerated water – initial water fill, flushing or fresh make-up water during operation
- From pressurisation problems – negative pressures at the top of systems results in air being drawn in through air admittance valves (AAVs) or seals
- From oxygen diffusion – through the use of non-barrier plastic pipework or inappropriately open cisterns.

The pipework systems should be installed in accordance with the manufacturers' guidelines by properly trained operatives. The guidance published in BSRIA BG 29/12 *Pre-commission cleaning of pipework systems* and BSRIA BG 50/2013 *Water treatment for closed heating and cooling systems* provides key rules that set the systems ready for a potentially long and effective operational life.

Pre-installation pipework and fittings should be protected from moisture and the influence of weather so, for example, it should not be stored directly on the ground, and should be kept under cover when being transported, with protective endcaps remaining on system components until immediately before use. Pipes of dissimilar metals should be stored separately to avoid contact corrosion, and parts of pipe with visible red rust should not be used.

The outside of installed pipes should be appropriately protected not only thermally, but also to resist the diffusion of moisture from the atmosphere that would cause condensation on pipework surfaces that are below the dewpoint temperature.

Manufacturers[5] recommend pressure testing with compressed air. However, when testing with water, the correct water quality should be used, and then the systems should preferably be left filled. If unavoidable, refilling should be performed as quickly as possible – preferably within 24 hours. It is important that the building operator is properly trained and understands about possible causes of corrosion and how to avoid them. For example, the systems should be operated at appropriate pressures so that water is not regularly released through pressure-release devices and then replenished with fresh water when the system pressure reduces.

Figure 3: A sample of the thin-wall carbon sampled from the 12-year-old installation at the Mater Hospital (Source: Geberit)

Monitoring for longevity

The rate of corrosion and risk of failure depends on a variety of factors including the chemical and microbiological environment, temperature, flowrate and not least the thickness of the metal.[6] Therefore, as well as ensuring appropriate installation techniques, proper maintenance and monitoring is required. Two current tests are typically employed – ultrasonic thickness tests and manual sampling. Ultrasonic thickness tests are useful in determining the current condition of the system but only give a snapshot of the system at that moment. Without regular repetition, finding a problem before it develops into a major failure may simply rely on good fortune. Manual sampling techniques that may be conducted every few months will not necessarily give enough data to understand trends in the system.

Water-monitoring systems are now well established and, with new technologies being developed, the real price of such systems is reducing. As discussed (and detailed) by Munn,[4] such systems can check continuously on engineering aspects, water characteristics and corrosion rates. Water monitoring should not be considered simply as a retrofit once a system has gone awry, but properly included as part of the initial design.

Turn to page 22 for references.

» Module 133

October 2018

1. For how long have commercial press-fit systems been available?

- ☐ A Under 10 years
- ☐ B Between 10 and 25 years
- ☐ C Nearly 35 years
- ☐ D Since the 1970s
- ☐ E More than 50 years

2. What is the maximum carbon content that would be expected in low carbon steel?

- ☐ A <0.1%
- ☐ B 0.2%
- ☐ C 0.3%
- ☐ D 0.4%
- ☐ E 0.5%

3. Which of these metals has the highest galvanic potential?

- ☐ A Aluminium
- ☐ B Copper
- ☐ C Mild steel
- ☐ D Stainless steel (416)
- ☐ E Zinc

4. Which of these months saw the highest relative copper price compared with steel?

- ☐ A May 1996
- ☐ B November 2001
- ☐ C August 2004
- ☐ D April 2007
- ☐ E January 2010

5. Which of these is not a requirement to ensure appropriate life of low carbon pipework?

- ☐ A Installed pipes protected from condensation of moisture from the atmosphere
- ☐ B Low carbon press-fit piping systems should only be used for chilled water
- ☐ C Pipes of dissimilar metals should be stored separately prior to installation
- ☐ D Pre-installation pipework protected from influence of weather
- ☐ E Systems operated at appropriate pressures

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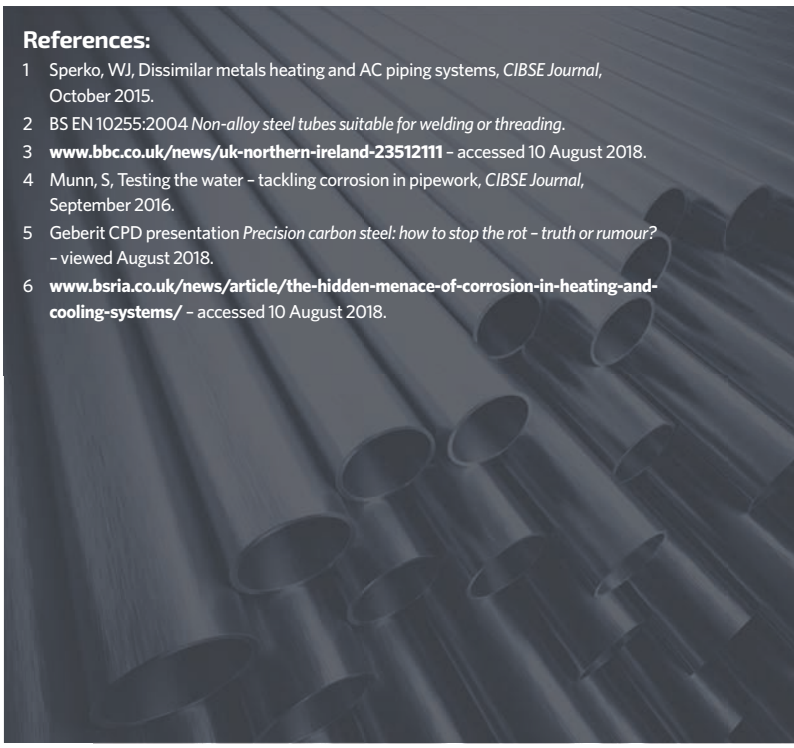

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Optimising for domestic hot water

When designing for buildings with a high domestic hot water requirement, it makes sense to take advantage of low carbon heating technologies. **Ian Dagley**, general manager at Hoval, considers some options

Compared to other types of building, hotels and other hospitality venues often have a relatively high demand for domestic hot water (DHW), in relation to heat loads for space heating. In such situations, the choice of heating plant and the control strategy applied will be critical in delivering optimum performance and efficiency.

This can be illustrated by considering the opportunities for including solar thermal in the heating mix and may require a rethink of traditional strategies. For example, many such mixed heating systems have been designed to use renewables as a supplementary 'top up' source to the traditional heating technologies. Inevitably, this imposes limitations on the use of the renewable element and, in most cases, is not the optimum configuration.

A better solution when solar thermal heat sources are included in the system is to use the solar energy as the pre-heat source for DHW and supplement from other heat sources.

In this pre-heat configuration, the system is fitted with a mild steel vessel to store the water heated by the solar panels. This water is then used to pre-heat the DHW via a plate heat exchanger, with heat from other sources used to achieve the required DHW temperature, if needed.

Where high storage volumes are required, such as a hotel, a number of non-potable thermal storage vessels can be piped in series. This also helps to meet demand at peak times. Good stratification will promote solar gain and allow integration of other renewable heat sources.

Because the solar-heated water is isolated from the potable DHW supply, there is no legionella risk, so the water in the mild steel vessel does not have to be subjected to daily pasteurisation. The water stored in the DHW vessel(s) will still be subject to anti-legionella measures, but this would be happening anyway.

Such an arrangement also means that this heat energy can be used even on days when solar irradiation levels are low. As long as the stored water is at least 6°C above the incoming mains water temperature, there is an opportunity to achieve a worthwhile heat transfer.

CHP and heat networks

With the introduction of small-scale combined heat and power (CHP) to the market, many hospitality venues are now able to take advantage of this technology as part of their heating mix. In these cases, a balance needs to be struck between the heat and electrical power generated by the CHP by maximising its run times.

Here, again, inclusion of thermal storage capacity can be useful because it enables the CHP to keep running once the building's immediate heat loads have been satisfied, thereby increasing the amount of onsite power generation.

Control

In all these cases, efficient control is essential. Experience has shown that trying to control the multiple heat sources with different controllers is extremely difficult and will usually compromise overall performance.

Consequently, modern controllers now need a 'wider remit' so they can take effective control of a range of heat sources, and be able to handle single units or operate cascades of heat sources. For example, it is now possible to install a single controller that will control CHP, boilers, heat pumps, solar thermal and other heat sources that may become available in future.

Such controllers should also enable remote monitoring of plant performance, with alerts for routine or reactive maintenance.

For further information, visit **www.hoval.co.uk**

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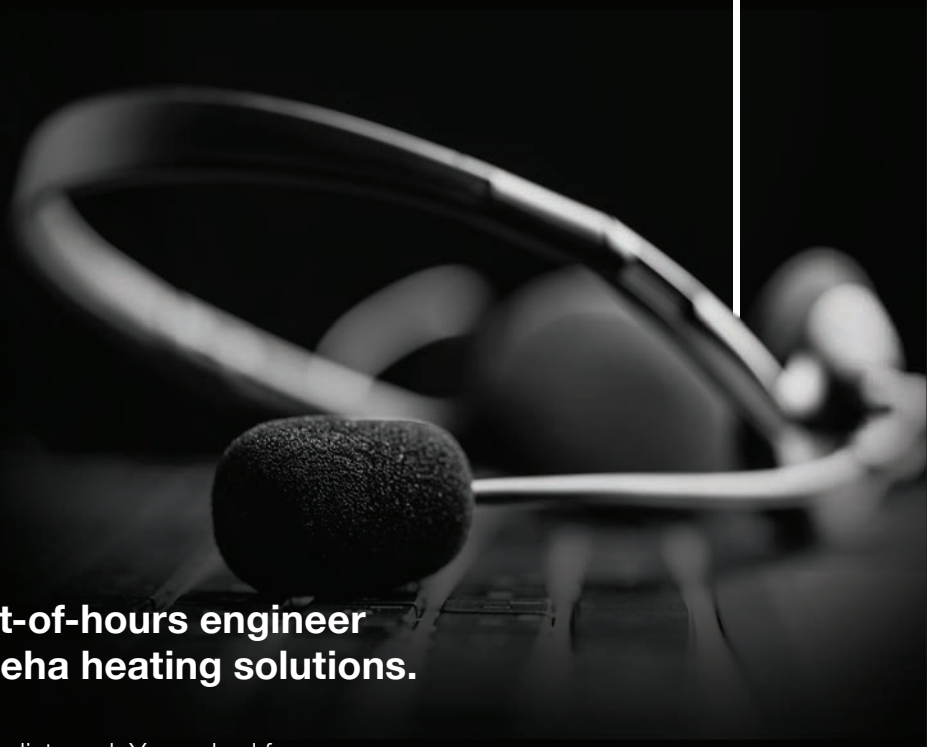

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