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A sanitaryware and infection control specialist who gained much of his 30 years' plumbing and water hygiene expertise and experience at Armitage Shanks before establishing his own consultancy, has set up two new UK businesses to market two 'ground-breaking new plumbing products' aimed squarely at healthcare facilities. The first is a radically designed clinical washbasin developed to minimise the risk of cross-infection and 'vastly reduce' healthcare-acquired infections, while the second – reportedly the world's first complete single pipe recirculation system for hot and cold water supply – is designed to prevent heat loss or heat gain through its 'self-insulating pipework' structure. *HEJ* editor, Jonathan Baillie, reports.

The founder and managing director of the two newly established companies, Angel Guard and Water Kinetics respectively, is Jonathan Waggott, who will be well known to many in the water and plumbing sector for his water system expertise. Having joined Armitage Shanks in Staffordshire in June 1987, he subsequently held roles there including senior Product manager, Product director (B2B), and Marketing manager (New Business creation). Leaving the company in late 2016, he then established his own consultancy, Jonathan Waggott & Associates. The holder of a Chartered Institute of Marketing Postgraduate Diploma in Marketing and Sales Management, he has a strong background in product marketing and new product development. His consultancy was thus not only able to offer a broad range of marketing, market research, and product design services, but has also established strong working relationships with NHS Trusts and Health Boards across England, Wales, and Scotland, as a provider of advice on infection control and water management, as well as of CPD training.

Excellent contacts

Jonathan Waggott has excellent contacts among a range of personnel in both the public and private healthcare sectors across the UK for whom managing water systems is a key responsibility. He acknowledged, when I met him recently, that in developing the new Angel Guard system, and in preparation for the launch of the Eco-Duo system, he had taken strong account of the feedback from healthcare estate management, healthcare engineering, and clinical staff during his many visits to healthcare facilities about some of their more intractable infection control challenges.

He said of his own background: "Before undertaking my Postgraduate Diploma in Marketing and Sales Management at the University of Wolverhampton, I undertook a BTEC in Design & Engineering at Cannock College. I later joined Armitage Shanks in sales, before moving into external sales, marketing, and product management. In my later years with the firm I was responsible for the Non-Residential sanitaryware businesses for both Armitage Shanks and Ideal Standard. On leaving the company, I set up my own consultancy." While this offered a broad spectrum of services – from product marketing to infection control and water hygiene expertise – he found himself increasingly working with other sanitaryware and plumbing manufacturers to help them develop new products. There was a particular focus on systems which would help protect patients against waterborne bacteria. The launch of the two new companies, and the development and introduction to market of each's initial products, was thus 'a logical next step'. He explained: "The first of the two new companies, Angel Guard, is a business that aims to provide protection at point of use against infections caused by waterborne pathogens, such as *Legionella* and *Pseudomonas aeruginosa*."

The circular Angel Guard washbasin is fitted at a 45° angle to the surrounding IPS panel. Both are made from easy-to-clean materials.

Working with 'key people'

Before talking in more detail about Angel Guard, he explained: "After setting up my consultancy, I immersed myself in the world of Authorising Engineers, microbiologists, estates and facilities personnel, and infection control specialists, to understand the key issues for them. It became clear that many of the infection risks to patients occur at point of use, for example at washbasins, taps, in basin wastes, and showers. I was already familiar with the issues, but as an independent consultant, was able to have considerably more in-depth conversations with the aforementioned personnel. With my design and engineering background, and their input, I began thinking about how we could address some of these problems, and particularly about how a washbasin and a shower station designed to minimise infection risk might look if we tried to solve all of these problems one by one."

Established with his wife

Jonathan Waggott explained that the resulting system – the first Angel Guard product to market, would be what the company says is 'the world's first clinical washbasin system with Artificial Intelligence technology built in'. He said:

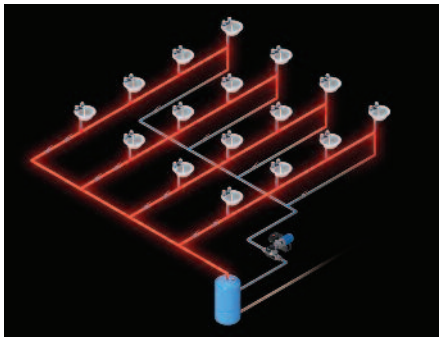
"My wife, Elaine (who has extensive experience in the sanitaryware and finance sectors), and I, have set up the company together. Angel Guard, and indeed Water Kinetics, are based in East Kilbride near Glasgow, where we have leased an office and production facility, which we will be fully staffing early this year."

Addressing a gap in the market

The 'idea' for the new clinical washbasin first came to him in June 2017. He elaborated: "I kept hearing that there was no washbasin solution available that really effectively addressed the issue of cross-contamination." One of the major issues the new Angel Guard units seek to address is splashing from such units, and the resulting risk of spread of harmful waterborne pathogens to adjoining personnel, surfaces, and medical devices. Jonathan Waggott elaborated: "Such splashing carries a number of risks – the water itself can be infected with pathogens including *Legionella*, *Pseudomonas aeruginosa*, *E. coli*, or MRSA, the tap or shower components can be contaminated, and there can be biofilm build-up within the tap or shower, and particularly within the thermostatic mixing valve; this can make its way into the washbasin and splash either from hands, or by water hitting different parts of the washbasin."

"Our aim," he continued, "has been to engineer out many of the issues that heighten infection risk in 'conventional' clinical washbasins, while also creating a retrofittable unit. We are also using technology, including AI, in a very new way, to provide a safe, secure means of constant risk assessment, and delivery of counter-measures at point of use."

While a dedicated website on the new Angel Guard washbasins – the 'Gabriel', and the slightly more advanced 'Michael' with a number of extra features – provide considerable detail, the company has also produced a launch video, which Jonathan Waggott showed me. Before focusing on the washbasins' key selling points,



Water Kinetics says that 'traditional re-circulation systems allow the water to cool down, as they often don't recirculate up to point of use, and have long single pipe return legs'.

When the user waves their hand in front of a small infrared sensor to start the water flow on the Angel Guard basin, a screen in the IPS unit above the basin begins displaying images (with the Gabriel), and a full video (with the Michael), accompanied by a countdown timer, to guide them through effective handwashing.

it provides some interesting context on the scale and costs of hospital-acquired infections, and on some of the existing 'issues' with conventional clinical washbasins.

The growing issue of antibiotic resistance

The video points out that, according to the World Health Organization, antibiotic resistance is 'one of the world's biggest threats to global health, food security, and development, today'. It adds: 'Dr Paul McDermott, a world-leading microbiologist specialising in waterborne pathogens, advises that it is commonly recognised that water outlets such as taps and showers can harbour harmful bacteria, and can transmit these to patients'. Consequently, the video argues, handwash stations and showers 'need to be treated as medical devices, rather than just sanitaryware'. It also reveals that 'the latest published NHS figures' indicate that at least 4 per cent of all hospital patients will contract a healthcare-acquired infection, with the current average annual cost per hospital 'to try to control the spread of waterborne pathogens', over £1.8 m. However, this cost is, it says, 'insignificant compared with the cost to the hospital of looking after those who have contracted an HAI'. Additionally, while the average NHS inpatient stay length is 2-3 days, this rises to 21 days when a patient has contracted an HAI, 'costing, on average, £38 m, per hospital, per year'. When other 'associated costs' are factored in, Angel Guard says the average annual HAI-related cost to an acute hospital is around £41 m. Against such a backdrop, the video says 'it is clear why a solution is urgently needed'.

Many issues already identified

Stark data, but the video goes on to suggest that many of the issues that require addressing to reduce HAI numbers have already been identified. One of the most notable risks is the aforementioned 'splashing' from clinical washbasins, which can see surfaces up to two metres away contaminated. Equally, placing objects on basins can lead to infection spread via contamination. 'With current waste systems, the bacteria from within the trap can travel upward into the sink, contaminating the surrounding area when the tap discharges into the basin, and spreading pathogens through splashing.' Another potential risk is 'prohibited' liquids and solids being poured into clinical washbasins; these 'provide an excellent food source' for bacteria, while blocked clinical washbasins may result in 'even greater splashing' of contaminated water across local surfaces.

Multiple contact points

The video goes on to add that 'traditional' TMVs 'can contain complex waterways, and many plastic parts, which can lead to possible biofilm build-up', while traditional IPS panels can also provide areas where bacteria can collect and grow. There are also many opportunities for bacterial contamination due to the multiple contact points – such as taps, soap, and hand gel dispensers – that often have to be touched to be used. Angel Guard clinical washbasins offer 'contact-free delivery of water, soap, and hand gel, without the use of solenoid valves.' They also feature biofilm sensors within the tap spout and hot and cold water inlets.

'Sporadic' monitoring

Monitoring of hot and cold water temperatures is clearly an essential part of good system maintenance, but – the video says – tends to be undertaken 'sporadically and manually', while auditing of cleaning can be 'extremely challenging', with cross-contamination of cloths commonplace. Collecting accurate data on all aspects of a potable water system can be 'very difficult and costly', while handwashing compliance levels in hospitals are 'often below 40 per cent'.

While, until now, the video maintains, these issues have been 'almost impossible to manage', 'a solution is now available' – the new Angel Guard clinical washbasin – 'the world's first fully automated, sanitary medical device with AI capability'. Here the video moves to describe the benefits and features of the two current Angel Guard washbasins – the 'standard' Gabriel unit, and the 'most powerful' Michael. The latter is designed for 'higher risk' clinical areas; it incorporates all the Gabriel's features, plus fully automated chemical and thermal disinfection and mixed water flushing, and an additional two biofilm sensors. Both units can be specified with ProEconomy copper/silver ionisation, and both come as standard with 'Halo Protect'– a 24-hour manned support

David Harper's view of Eco-Duo

David Harper, a world-renowned public health engineer, is a Fellow of both IHEEM and the Water Management Society, and the holder of an IHEEM Lifetime Achievement Award. He holds an Honorary Fellowship from SoPHE, and in 2018 was awarded the Freedom of the City of London and inducted into the Worshipful Company of Plumbers.

Pictured here presenting at last year's World Plumbing Conference 2019 in Melbourne, he says of Eco-Duo: "Eco-Duo is a real game-changer, and with WRAS approval anticipated in March, I don't think it an exaggeration to say it will change the world of potable water systems globally. To be able to reduce energy costs by 50%, halving installation time, insulation cost, and the number of pipe fixings, seemed too good to be true, but on travelling to Bristol to meet the inventors and see the prototype, spanning four floors within a prominent University, I saw for myself that it is indeed possible. Not only did the system work incredibly efficiently, but it also eliminated the *Legionella* pathogen persistently present prior to its installation.

Innovative isolation valve

"As part of the system," David Harper continues, "there is an innovative new Eco-Duo CIV (Continuous Isolation Valve), which, for the first time, allows the water to continue circulating even when an area of pipe requires isolating to allow work to be carried out.

"Another great feature is the clever Confluence T, which creates the connection between either the heater or the refrigeration system being used and the pipework, making installation incredibly simple and quick. With only half the pipework of a 'conventional' recirculation system required, consulting engineers and architects will be able to reduce the complexity of plumbing systems, and increase significantly their usable space across the entire building.

"The manufacture, testing, and materials selected to create this copper pipe system will be welcomed by estates managers, infection control specialists, and microbiologists alike, with clean manufacture, dry nitrogen testing, and pathogen-resistant raw materials bringing a solution to the issue of products arriving on site already contaminated. Water Kinetics will be using recycled packaging, while over 90% of the product is recyclable; add this to the reduction in energy and fitting material costs, and it all goes a long way towards achieving the tough targets set for BREEAM 'Excellent' and LEED 'Platinum' accreditation. It is so gratifying to see that boundaries are still being pushed, and new innovations still being created."

service provided by Angel Guard's 'Guardian' staff, which provides personal monitoring of all units, and co-ordination of responses and actions, with both hospital staff and Angel Guard's field-based 'Service-Scientists'. In addition, 'in-depth, real-time reporting', including the ability to produce reports specifically for Infection Control personnel, Water Safety Groups, Authorising Engineers, and Estates personnel, is included as standard.

Unconventional shape

Both units demonstrate considerable innovation, but one of the most radical design aspects – which Angel Guard says is key to reducing the splashing seen with more 'traditional' basins – is the circular washbasin itself, a patent-pending glass tube fitted at a 45° angle to the surrounding IPS panel. The IPS surround, and the washbasin and its outlet, are produced from 'naturally antimicrobial materials' such as glass and copper, and are thus easy to clean. Angel Guard says they were chosen, 'after extensive research', as 'among the most resistant to bacteria'. The washbasin is made of clear glass, and mounted immediately above it is a second, smaller cylindrical glass tube, which incorporates a 'hidden' one-piece copper outlet containing no plastic parts, flow straighteners, or aerators, where biofilm can build up. The outlet discharges the water through a small aperture into the basin below. A 'Hygienic Mixing Valve' (HMV), 'providing all the benefits of a TMV, but delivering water in a safer way', uses 'new technology, and not rubber/plastic' to mix the water. The washbasins feature high capacity Pall Medical filters, which also remove *Cryptosporidium*.

The video and website explain that the washbasin's cylindrical shape, and the angle of fitting to the IPS panel, were designed specifically to help eliminate splashing, and thus prevent spread of harmful waterborne pathogens from clinician to patient, 'even when a user's hands are interrupting the water flow'. Due to the outlet position, and the basin's fitting at 45 degrees to the IPS unit, residual water from handwashing flows straight into the waste outlet and trap, which are both 'wider than normal', rather than splashing back and potentially out of the basin. Water used for washing thus flows directly into the sewers 'uninterrupted'; the waste outlet and trap also incorporate 'a special device' which 'eliminates trap contents from coming back up the basin'. Angel Guard says: "The design was developed to make it extremely difficult for waterborne bacteria such as *Pseudomonas aeruginosa* to be splashed onto bedding, patients, sterile apparatus, nurses' and doctors' clothing, and drug preparation equipment etc." While the unit's front and sides are toughened glass, to facilitate cleaning, the concealed tap outlet is 'hidden', and positioned within an air gap so that cleaners cannot touch it and thus cross-contaminate it.

Handwashing compliance

Ensuring staff compliance with hospital handwashing protocols can be challenging. To address this, once the user activates the water flow on the Angel Guard washbasin – by waving their hand in front of a small infrared sensor – a screen in the IPS unit above the basin begins displaying images (with the Gabriel), and a full video (with the Michael), accompanied by a countdown timer, to guide users through the various steps of an effective handwashing process. The Michael can identify individual users by reading the 'chip' on a 'unique' wearable RFID tag, which can be discreetly incorporated into a staff badge. Individual and group 'handwash history' are thus available in downloadable and printable form for review both by clinicians and nurses, and, say, by Infection Prevention Teams – as Angel Guard puts it, 'providing real-time and historic data to help ensure that high levels of compliance are achieved'. Jonathan Waggott said: "The system is also massively water-saving, since water is only run when it is needed to wet and then rinse the hands (pausing while the soap is applied), and again when hands are being dried."

Although some medical staff might be resistant to having their handwashing so closely monitored, Jonathan Waggott said Angel Guard had found the 'vast majority' 'very receptive'. He said: "We will not only be providing full training, but also

letting all users of the new washbasin understand the reasons for its installation, and its key features and benefits. We will be stressing how it can save lives; we'd thus expect most clinical and nursing staff to be supportive."

Inappropriate or inadequate cleaning of clinical washbasins can also pose considerable infection risks, and, accordingly, a Cleaning Protection System on the Michael not only monitors who has cleaned the unit – via wearable RFID tags, but also for how long and when. It also 'alerts' should unauthorised liquids be poured into the basin, shuts off the unit for decontamination, and 'identifies the staff member so they can be re-trained'. The system can also detect if a cloth has been used to clean more than one unit.

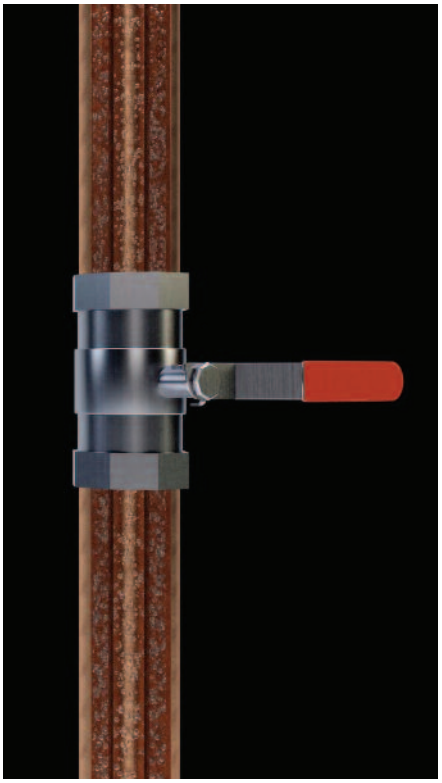
How the units monitor

Angel Guard units feature a variety of precision sensors 'monitoring many parameters 24/7'. Using the data collected, and other data, each unit risk assesses itself '24/7' Each unit risk assesses itself '24/7' based on such information, and other data – such as when and what the last 'counter-measure' issued was, and its effectiveness. An ongoing 'risk level' is then assigned to the unit, and, if required, a 'counter-measure' will be either requested (Gabriel), or issued automatically (Michael), with all actions and data stored for future reference. 'Appropriate alerts' are created, depending on the levels of biofilm present, all of which are followed up by their 'Guardian' staff. The company said: "Angel Guard units provide intelligent information, to allow targeted water testing to be done when required."

Counter-measures

Even with the best water system monitoring, of course, there is a chance that bacterial contamination can occur. All Angel Guard units thus incorporate 'automated counter-measures'. On Gabriel units a built-in 'intelligent flushing system' will automatically produce a mixed water flush 'only when risk levels are deemed high enough to require this'. In addition, thermal disinfection can be activated 'in a secure way' while being observed by a staff member. Michael units also provide automated chemical disinfection of the hot and cold pipework, the Hygienic Mixing Valve (HMV), tap spout, the waste pipework, and trap. The unit can also deliver fully automated thermal disinfection. Both units can be pre-installed with a ProEconomy copper/silver ionisation system, which delivers copper/ silver ions throughout the unit at point of use, 'to help to keep pathogen levels low during each washing cycle'.

Incorporating 'a pipe within a pipe', Water Kinetics' Eco-Duo water recirculation system sends the water out on the inner of the outer pipe, and then back through the inner pipe.



The new Eco-Duo (Continuous Isolation Valve) allows the water to continue circulating even when an area of pipework requires isolating to allow work to be carried out.

24/7 monitored alerts

Angel Guard explains that all alerts issued by its units are responded to '24 hours a day, seven days a week', by its fully-trained 'Guardians'. Via its 'Halo Protect' service, they monitor all units from a UK control centre, responding to alerts, and liaising with staff such as infection control and estates teams to gather more information. In addition, fully trained and certified 'Service Scientists' will regularly visit the units to calibrate all sensors and ensure that ongoing reliable data is gathered. If required, units can be remotely shut down.

'Colony Technology'

Angel Guard says its patent-pending 'Colony Technology', which harnesses AI, can provide 'complete protection across the entire healthcare building'. It explains: "Each individual unit gathers data, sending it to the AG Cloud. The AG system then identifies AG units within the same area, and enables them 'to speak to each other', and risk assess as a 'cluster' of units. If a higher risk level is detected on one unit, other units within the same area can be put onto a heightened 'state of alert' – gathering data with a higher frequency, and issuing preventative counter-measures across a group of units. This helps to prevent systemic pathogen contamination." The AI technology is also designed to indicate which 'counter-measures' are proving most effective.

Cyber security

The Angel Guard clinical washbasins utilise 'a fully closed' data system, with external access limited to authorised users. All units feature magnetic locks to prevent unauthorised access, while 'military grade' security measures include no use of Wi-Fi, and the sending of only fully encrypted data packets from each unit. Angel Guard says: "Personal and sensitive data is not stored locally (including on RFID tags); instead it is kept only on our safe and secure remote cloud system."

Clean manufacture and installation

Angel Guard will assemble all the clinical handwashbasins in a cleanroom environment at its East Kilbride base, and rather than being water tested, they will be tested using dry nitrogen gas. The company says: "We are changing the standard of manufacture and installation of healthcare sanitaryware, with our units produced in a clean environment, dry-tested, made to order, and packaged in environmentally-friendly packaging. We use our own installers, with clean overalls, shoe covers, and gloves, using sterile tools for the installation, as well as for all subsequent commissioning, servicing, and maintenance. Once our units have been installed and commissioned, we will monitor them 24 hours a day, seven days a week, maintaining and servicing to ensure their smooth running, managing

any alerts and counter-measures, creating and providing reports, and providing a personalised service to the customer."

Cost savings and pricing

Alongside the benefits already outlined, Angel Guard says that if the NHS replaced existing clinical washbasins with Angel Guard units, it would save £39 m per year, per hospital. I guessed that the new clinical handwashbasin would command a premium price. Jonathan Waggott said: "The Angel Guard units will be more expensive than a 'standard' clinical washbasin, but we will be producing different versions, so hospitals can choose only the features they require. For instance, the base unit incorporates a hand hygiene system, but not the comprehensive one with the RFID tagging facility. We will also provide – for the first time for such a product – a financing option for the NHS, via which we will introduce the hospital to an NHS-approved low-cost finance provider, and they can finance their units over a period of five years. In addition, we levy a monthly service fee, which pays for the '24/7' service, and covers all parts and labour for five years. Our pricing also covers the washbasins' 'clean' manufacture, delivery, installation, and commissioning; from then on the service package covers all the ongoing support for the duration of ownership." Users pay a low monthly fee for this 'Halo Protect' package.

A favourable response in hospitals

The system has already been showcased to a variety of healthcare staff and Water Safety Groups in 'around 20' UK hospitals, with 'a largely extremely positive response'.

The second new innovation – to be marketed under the Water Kinetics brand by a second new company, is Eco-Duo, dubbed 'the world's first complete single pipe recirculation system, which, due to its innovative technology, prevents heat loss or heat gain through its self-insulating pipework structure'. Eco-Duo was developed by three Bristol-based engineers – the system's inventor, Maxwell Bridges, FM and health and safety specialist, Martin Pearce, and highly experienced factory engineer, Keith Ball; the trio are the company's co-founders. Jonathan Waggott explained: "Max Bridges, who is currently a Facilities engineer at the University of Bristol, has many years' facilities management, engineering, and water management expertise. About two years ago, David Harper, a world-renowned water safety expert with particular expertise in *Legionella*, suggested I view Eco-Duo in use at a university, and I when I saw it, I thought it was amazing. They have a prototype installed over four storeys, which has been in use for almost three years."

The founder and managing director of the two newly established companies, Angel Guard and Water Kinetics, Jonathan Waggott, who will be well known to many in the water and plumbing sector, and his wife, Elaine, also a former Armitage Shanks employee, who will be Operations director.

Energy reduction and constant temperatures

Using the system, Jonathan Waggott explained, the system's inventors are reportedly achieving a 48 per cent energy reduction, and maintaining constant hot water temperatures throughout the building, while 'seeing no issues' with waterborne pathogens. Following his initial visit, the inventors asked him to 'come on board' to help commercialise and launch the product. He explained: "I will be MD of both businesses – Angel Guard and Water Kinetics, and my wife, Elaine, Operations director."

"Eco-Duo," he explained, "is a completely new concept for potable water recirculation, that can work just as well on hot as on cold. Incorporating a pipe within a pipe, it sends the water out on the inner of the outer pipe, and then back through the inner pipe. This insulates the return water, and thus provides a constant temperature throughout the building, which massively reduces the potential for growth of waterborne pathogens like *Legionella*."

Jonathan Waggott added: "In a standard building, the hot supply has an outgoing supply pipe and a return pipe, but with Eco-Duo we have 'merged' these into one piping solution. In many buildings now – due to the increase in cold water temperatures throughout the summer – they are starting to recirculate cold water too, and Eco-Duo can also do this. While at the University of Bristol, we saw a 48 per cent reduction in energy use, we have recently completed a major study with the BRE in Watford, which showed a 50 per cent energy reduction and temperature loss compared with a conventional hot water recirculation system."

An engineering challenge?

The Eco-Duo system currently uses copper pipe. Jonathan Waggott said: "We supply the pipe and all the special copper press fittings, which are installed in exactly the same way as with a standard system. It should take the plumbing contractor just half the time to install the product, because you are only installing one pipe, and there is also a reduction in the duct space used. We also halve insulation costs, and the cost of the pipe fixings. Overall, Eco-Duo offers 50 per cent lower labour costs and installation time, while halving the costs for pipe fixings and insulation. The building owner will see a constant reduction in energy bills too."

Using Eco-Duo, Jonathan Waggott explained that a hospital's healthcare engineering team can deliver hot water at, say, 60˚C, and it will reach point of use with minimal heat loss, due to the insulation of the return within the 'pipe within a pipe', and the design of a system that recirculates water right up to the tap or shower. He said: "Because we are delivering the water at a high temperature throughout the building, measures such as thermal disinfection might not be needed. Like Angel Guard, we feel the Water Kinetics system is pretty revolutionary." A video on the new Water Kinetics website explains Eco-Duo's operational benefits in more detail.

Angel Guard is currently patent pending, while Water Kinetics has had its patent granted in the UK; both companies will be looking to extend the patents out to overseas territories.

Jonathan Waggott concluded by telling me that with manufacture of both new products due to start early this year, he and his colleagues were 'extremely excited' about the next few months ahead. **hej**