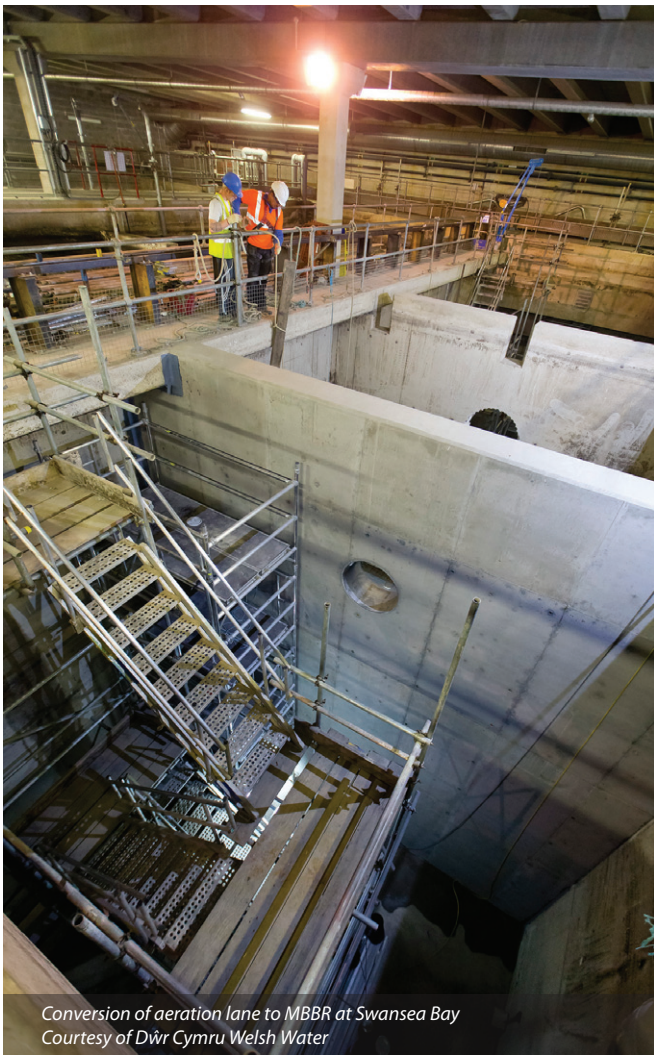
Swansea Bay WwTW

MBBR and DAF solution: an innovative process solution to enhance performance for Dŵr Cymru Welsh Water

by Andrea Burgoyne

Originally designed to treat a population of 165,000 Swansea Bay WwTW now serves a growing population in South Wales that has reached a PE of 185,000. The existing facility comprised screening, FOGG (FOG and grit removal) lanes, lamella PSTs, ASP utilizing lamella FSTs and UV disinfection. There is also a sludge digestion facility on site with an associated centrifuge. The majority of the works is located in an underground building that is covered with landscaping. At the back of the works runs Fabian Way, one of the main roads into Swansea and the front of the works is the proposed location for a new campus area for Swansea University. Dŵr Cymru Welsh Water identified a need to improve the treatment performance of the Swansea Bay WwTW as there was a large cost in operating the asset in order to maintain compliance. The areas of the works that Welsh Water wanted to focus on were the screens, FOGG lanes, lamella FSTs and the UV plant and the basis of design was to ensure that the facility was capable of treating 215,000 PE.



Conversion of aeration lane to MBBR at Swansea Bay
Courtesy of Dŵr Cymru Welsh Water

Delivery pipe into MBBR at Swansea Bay
Courtesy of Dŵr Cymru Welsh Water

Developing a sustainable solution

Swansea Bay WwTW is a key works for Welsh Water and it is vital that the water quality in Swansea Bay is maintained, particularly as it is a designated Bathing Water.

Imtech has worked closely with Welsh Water and its operations team on a proactive basis since AMP4 to implement mitigation plans to ensure short-term compliance and to develop a long-term sustainable solution. The taskforce set up in AMP4 reviewed a number of different options for the site. Developing an innovative process solution to meet the identified improvement needs was not straightforward as there were difficulties associated with extending beyond the existing site boundaries.

The FOGG lanes were upgraded in 2011, the UV plant in 2013/14 and the screens are being upgraded in a separate scheme. The focus of the scheme described within this article is the activated sludge plant and lamella FSTs.

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Process Plant at Swansea Bay MBBR - Courtesy Dŵr Cymru Welsh Water

Pipework at Swansea Bay MBBR - Courtesy Dŵr Cymru Welsh Water

Looking at conventional solutions would have meant the following:

- Large scale customer impact both with the local and wider community.
- Challenging planning conditions that may have been prolonged and costly.
- Replacement of the existing final lamella settlement tanks: Capital cost in excess of £30m.
- Replacement of the existing works: Capital cost in excess of £200m.

It was concluded that the best solution to secure long term compliance was a change of process from the current activated sludge plant and lamella clarifiers to moving bed biofilm reactors (MBBR) and dissolved air flotation (DAF).

The use of the MBBR wastewater treatment process allows the provision of a higher level of wastewater treatment within the existing structures of a treatment works. The process increases the population of active biomass within a tank to give higher levels of treatment and can be retrofitted into existing structures.

Moving bed biofilm reactors

This emerging technology has been successfully applied for wastewater treatment solutions in cities across Europe, often where no additional land is available for extension of the treatment process. The benefits of MBBR include:

- Achieving higher standard of treatment.
- Minimum risk to compliance.
- Improved operational resilience.
- Allows you to meet the future challenges within the existing works.

Pilot plant

As MBBR is a new technology to Welsh Water, it was decided to build a pilot plant first, which could be monitored, before agreeing to the design and development of a full-scale MBBR solution. The pilot study utilised a 1:500 scale model, and ran for a two year period from October 2007.

The pilot plant enabled there to be confidence in the process change and confirmed the design of the full scale process by all stakeholders. Information from the pilot plant was made available to the suppliers of MBBR and DAF, which aided in focusing their design and minimising the capital spend.

Specifically with the MBBR, the pilot helped with reducing the number of MBBR lanes and enabled the reuse of the existing blowers. The DAF pilot helped to specify the flocculant requirements which resulted in a much smaller polymer plant than initially thought.

Conversion

There were 4 (No.) aeration lanes and 12 (No.) FSTs available for conversion. As the design progressed, it was established that only three of the four aeration lanes would need to be converted to the MBBRs treatment process. Of the 12 (No.) FSTs available, only eleven would need to be converted to DAF process.

A challenge with the conversion of the FSTs to DAF was the aspect ratio, with the tanks being long and thin, which is not the normal aspect ratio for DAF plant. One proposal was to change the aspect ratio by removing the dividing wall between pairs of FSTs, but this was deemed to be high risk and carried a significant capital cost due to the enclosed nature of the building and the difficulty of ensuring the structural integrity of the structures as they are all interconnected.

The solution chosen was to leave the aspect ratio as it was and to have a chain scraper halfway along the tank as, with the flow

conditions to each DAF, the velocities at the surface are sufficient for the float sludge to reach the scraped section.

Changeover methodology

A major challenge in planning this work was the changeover methodology of how compliance was to be maintained whilst changing from an ASP to MBBR/DAF. The consent requirements for Swansea are 50mg/l BOD and 60mg/l TSS on a 95%ile basis with flows up to 1,300l/s being treated to this level.

The changeover methodology identified the temporary over-pumping requirements and additional air required at the critical stages to ensure both processes are maintained. The methodology also assisted the subcontractors to understand the scheme and how their early involvement would affect the entire process whilst costing up and carrying out their work.

Construction

Construction at Swansea Bay WwTW started in Summer 2012, led by Imtech. The MBBR is supplied by Veolia Water Technologies and the DAF by Ovivo.

The civil works are being undertaken by Alun Griffiths (Civil Engineering), the mechanical install by Industrial Pipework Services and the electrical install by Zone Electrical.

The MBBR/DAF process has produced good effluent quality and on a comparative basis with the ASP/FST at the various changeover stages has consistently produced a better quality effluent.

Innovative lifting equipment

An innovative aspect of the construction was the installation of the media sieves that needed to be installed in each MBBR to retain the media. A lifting device was designed, which would safely enable the team to lift 48 (No.) stainless steel sieves, each weighing 65kg, into positions between two walls, 8m in height, within a confined space and with only 2.5m headroom.

Due to the low roof level and critical equipment positioned around the tanks, traditional forms of lifting equipment, such as cranes – either standard mobile units or mini (spider type) cranes – were not suitable. This left the team with the need to develop an innovative method of installation. The bespoke lifting device can be easily utilised to position the heavy sieves in exactly the correct position prior to being affixed to the structure.

Built from mild steel, the device was certified by Safe Way Lifting & Engineering Ltd of Nuneaton. The design was such that weight would be kept to a usable level, to allow final positioning of the unit on the surrounding tank wall.

The device works by being positioned on the top edge of the tank wall and clamped to the structure via four adjustable pads. When in place, the device positions the centre of gravity for lifting the sieves into the correct position. Once the sieve is in position, the team connects a hoist to the sieve and winch it into place.

Progress

Currently 2 (No.) MBBRs are in operation and the third is nearly complete. 6 (No.) DAFs are also operational, with a further two due for completion in Summer 2014. The entire scheme is due for completion in late Spring 2015.

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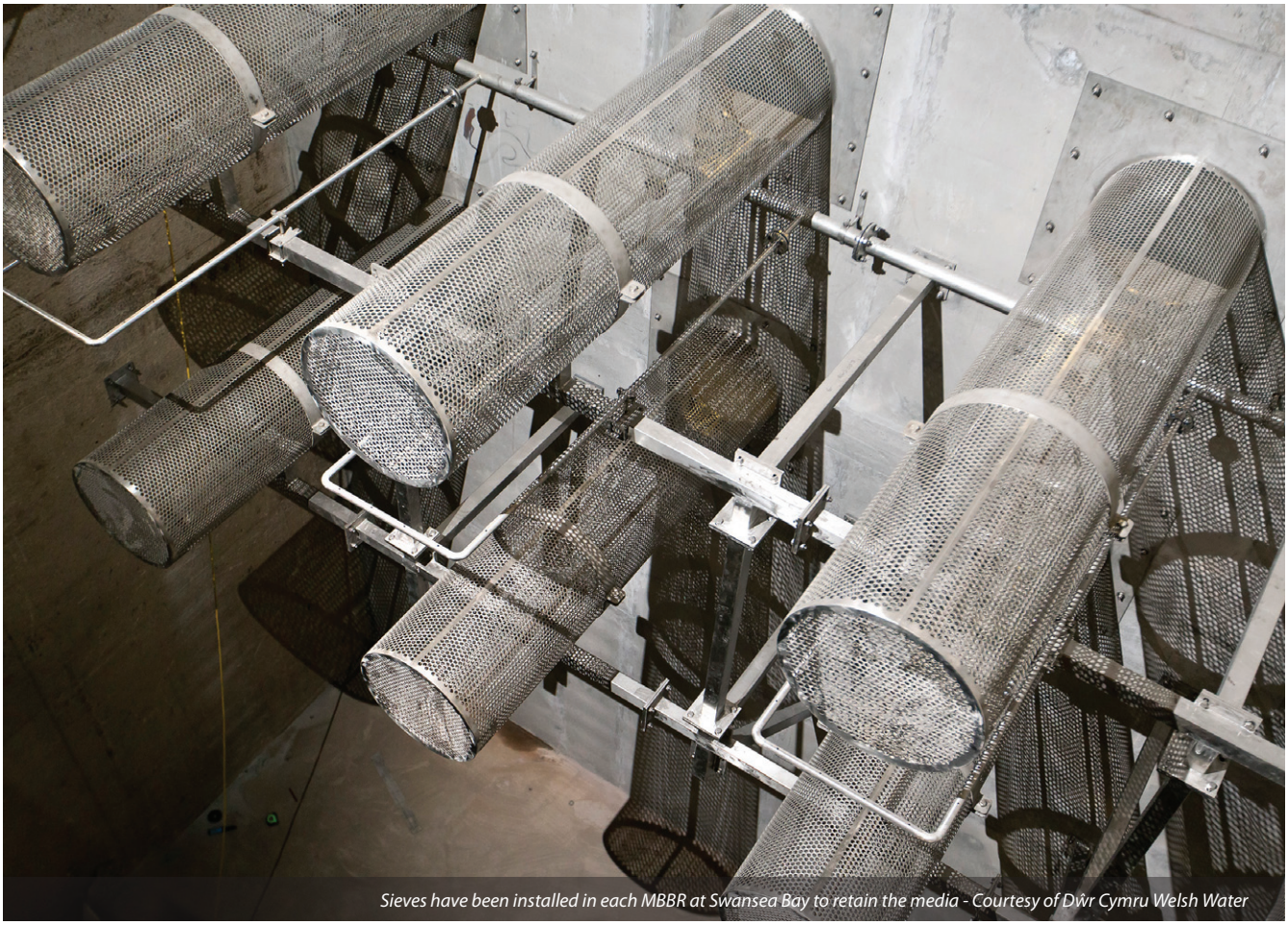

Sieves have been installed in each MBBR at Swansea Bay to retain the media - Courtesy of Dŵr Cymru Welsh Water