

Frankley WTW - Limewater Plant

an innovative solution for pH correction to maintain water quality for the City of Birmingham

by Jonathan Wagstaff BEng CEng MICE

Situated on the outskirts of Birmingham, Frankley Water Treatment Works has been supplying wholesome drinking water to the population and industries of Birmingham for over 100 years. During this period the processes have been enhanced, improved and replaced to ensure water quality standards are met and maintained. The most recent significant capital scheme at Frankley is the replacement of the existing lime plant with a new limewater batching and dosing plant. This new plant uses an innovative approach of fully dissolving lime in solution to ensure consistent quality and dose rates at each of the lime dosing points on site, which is important to ensuring the treatment processes are effective.



Limewater plant under construction - Courtesy of MWH Treatment

Ensuring water quality is consistently maintained

When Frankley WTW was commissioned in 1904 the original treatment process consisted almost entirely of sand filters. These have been replaced over the years with modern process plant to meet changes in demand, raw water quality and treatment standards.

Major alterations undertaken in the early 1990s included a lime batching and dosing plant in which hydrated lime and water are mixed to produce a 5% lime slurry which is then pumped to a number of dosing points across the site. Lime dosing is used for pH correction and water stabilisation and is important to the chemistry of the water to ensure treatment processes are effective.

The existing lime plant has been in service for over 20 years, is approaching the end of its useful life and requires replacement to secure future water quality for the site.

The existing lime plant

Having investigated alternative chemicals it was established that lime is still the most suitable product for this purpose at Frankley. Due to inherent issues the existing lime plant can be problematic to operate and maintain to meet the dose strength and rate at the dosing points. These issues include:

- Blockages in dosing lines due to calcium carbonate, or settled lime powder build up (due to low dosing line velocities, sharp bends etc).
- Maintaining a consistent batch strength due to weighing inaccuracies resulting from a build up of calcium carbonate or lime in the batch tanks.
- Specialist transfer pumps are obsolete and parts are difficult to obtain.
- The de-alkalisation plant is undersized, allowing calcium carbonate to form in dosing lines and pumps.

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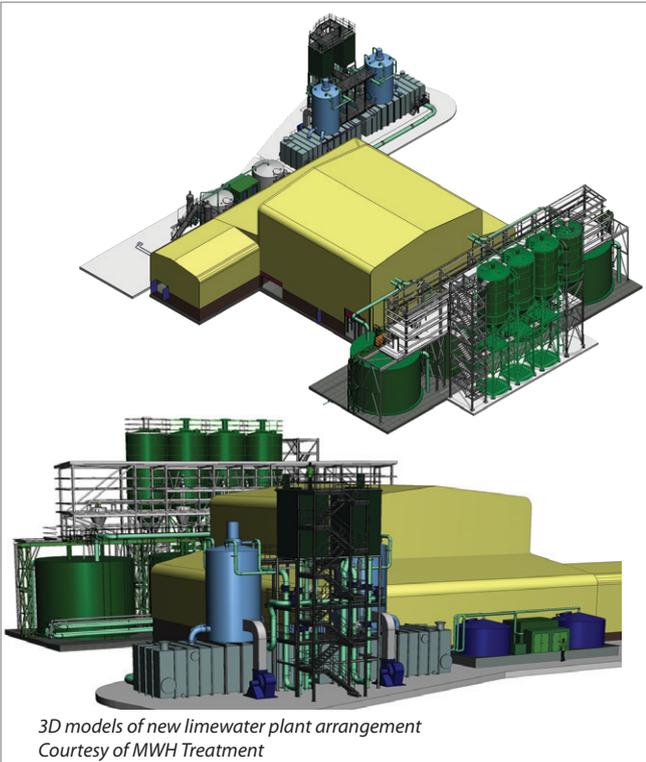
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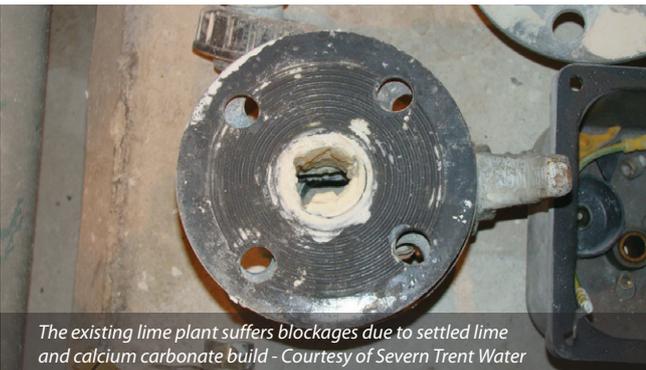
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3D models of new limewater plant arrangement
Courtesy of MWH Treatment



The existing lime plant suffers blockages due to settled lime and calcium carbonate build - Courtesy of Severn Trent Water



Factory fabrication of pumps and manifold prior to shipping to site
Courtesy of Severn Trent Water



Model showing existing building and new plant for off-site fabrication
Courtesy of MWH Treatment

To address many of the existing issues at source the new lime plant arrangement is able to use the latest technology to consistently produce a dissolved limewater solution (0.13% w/w) rather than a lime slurry.

The limewater solution requires more process water than a lime slurry to produce a batch but requires no motive water, so the overall demand for treated water is only approximately 35% greater than that for the existing plant.

Scope of services

MWH Treatment was appointed by Severn Trent to undertake the design and construction of the new lime plant, with Severn Trent Water retaining the responsibility for the process design. MWHT formed a joint venture with Costain to build on their experience of project delivery at Frankley WTW.

With an agreed target price for construction of £14m, initial enabling work started on site in August 2014, with significant progress completed on the permanent works by the end of May 2015.

The new lime plant

The new limewater plant, when complete, will be the first in Severn Trent and one of the largest in the UK. It comprises:

- A transfer pumping station to deliver process water for producing limewater.
- 4 (No.) lime silos with cross-connecting conveyors to maximise resilience. The design, fabrication and installation was subcontracted to Portasilo.
- 4 (No.) Batch tanks; each 420m³ glass coated steel tanks. The Permastore covered tanks were installed by Kirk Environmental.
- Dosing pumps and dosing lines.
- A de-alkalisation plant to prevent calcium carbonate build-up in the process, with the design, fabrication and installation subcontracted to Gee & Co.

The existing redundant sludge building on site was identified for reuse in this project to house M&E plant and equipment comprising control panels and pumps, resulting in a cost saving of £1m compared to providing a new building. Reusing the building required the removal of the existing 2 (No.) sludge presses. These were amongst the largest in Europe, around which the existing building had been erected.

Sub-contractors Adler & Allan were appointed to undertake the removal of the presses, which required considerable time and care to dismantle.

The presses each weighing 60 tonnes were supported on specialist jacking equipment whilst being cut and lowered in stages until the units could be fully dismantled and removed through the access at ground level of the building. Considerable planning went into this operation to ensure it could be carried out safely.

Other enabling works required the removal of redundant sludge tanks, both above and below ground, and service diversions of HV cables and drainage.

By November 2014 progress had started on construction of concrete base slabs around the existing building to accommodate the batch tanks.

Project delivery

Given the importance of the project and the increasing risk presented by the rapid deterioration of the existing lime plant, the programme for completing the new limewater plant was reduced by six months to 31 March 2016 as an undertaking to the DWI.

The tight deadline produced many challenges but aligned perfectly with Severn Trent's AMP6 vision and approach to meet their aspirations of 20% efficiency gains, 30% quicker and 30% greater productivity, and the philosophy behind these improvements.

Meeting AMP6 challenges

To meet the programme and Severn Trent's AMP6 challenges the following processes were implemented:

Lessons Learnt: Water companies with experience of the limewater process were engaged to establish where improvements could be made; for example one site had rectangular batch tanks to effect a capital cost saving but these were not completely effective at mixing; the new plant will use cylindrical tanks.

Staged funding release: Severn Trent Water released funding in stages, early during the approval process, to allow the contractor to procure 'long-lead-in-time' packages, to ensure their availability would not delay project progress.

Design for Manufacture & Assembly: A Lean construction workshop was held with the Client to establish Design for Manufacture and Assembly (DFMA)/off site construction; a key strategy for which STW has set a target of 70% off site manufacture in AMP6.

From the outset the design has been developed with a mind-set for off site production and involved the subcontractors responsible for each off-site element from the beginning. Off site fabrication of the de-alk plant, skid mounted pump sets, glass coated steel tanks, twin wall plastic chambers and other innovations has resulted in an actual off site fabrication of 85%.

The benefits to programme, efficiency, quality and H&S in delivering the project are clearly recognisable.

Innovation: BIM has been used effectively throughout the design stages to ensure all key stakeholders are engaged in the design process and that the off site fabrications will fit seamlessly with the on site elements when delivered.

During the design development MWHT used the very latest technology such as Virtual Reality headsets, taken from the gaming industry, to allow the Operators to 'experience' the lime plant and identify potential improvements for operability and maintainability.

The 3D model has also been loaded onto tablets to allow the O&M teams further flexibility to assess their requirements to improve the design where possible.

Production control/collaborative planning: Meeting another STW AMP6 philosophy, production control and collaborative planning techniques have been effectively implemented on this project and have successfully maintained progress ahead of programme.

Programme risk items have been identified early and eliminated or mitigated to avoid programme delays and the client's stakeholders have been engaged to ensure their assistance is planned in good time. To further enhance and secure programme certainty MWHT has used 4D programming to help plan the complicated installation sequences of the off-site manufactured pipework.

Progress to date

The project is on course to be delivered in January 2016, 2 months ahead of programme, and within budget. At the time of writing (May 2015) the existing sludge building has been fully stripped out, skid mounted pump sets have been installed in the building, batch tanks and lime silos are in place, and the concrete slabs for the de-alk plant are complete.

Summary

The new limewater plant at Frankley WTW is Severn Trent's first and will be one of the largest in the UK when complete. The programme for project delivery is important and MWH Treatment has embraced innovative strategies at the heart of Severn Trent's AMP6 delivery model to put the project in a strong position to be delivered early.

The editor and publishers would like to thank Jonathan Wagstaff, Project Sponsor with Severn Trent Water, for providing the above article for publication.



Hydraulic jacks support the removal of the existing sludge presses
Courtesy of MWH Treatment



Installation of pre-fabricated lime silos
Courtesy of Severn Trent Water