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Managing instability in anaerobic digestion

Commissioning and operating new anaerobic digesters always has its challenges. When the biology of the digesters goes wrong, it can take months to get back to normal operation, creating adverse time and financial implications for the project and client.

Peacehaven wastewater treatment works and sludge recycling centre **Image: Southern Water**

It will therefore come as no surprise that the project team encountered some 'interesting' challenges while commissioning the anaerobic digesters at the new wastewater treatment works and sludge recycling centre in Peacehaven near Brighton. However, the upside was that the extensive investigations they carried out led to new knowledge.

The digesters at Peacehaven WwTW are part of Southern Water's £300m environmental improvement scheme to bring cleaner seas to Sussex which is being delivered by 4Delivery (a joint venture between Veolia Water, Costain and MWH).

It all started well ...

Commissioning of the digesters started in September 2012. Two of the 20m diameter and 20m high digesters were seeded from a local reliable source of screened digested sludge. The feedstock to the digesters, consisting of co-settled biological aerated flooded filters (BAFF) and lamella primary sludge, was then progressively increased. This allowed it to eventually take the indigenous sludge load produced by the site, indigenous thickened fat, oil and grease (FOG) as well as the imported cake from Newhaven WwTW. The digester ramp-up procedure was very carefully controlled using a digester loading spreadsheet.

By the end of January 2013, the digesters were receiving their design load and all the digester key performance parameters (pH, dry solids, volatile solids, alkalinity and volatile fatty acids - or VFAs) analysed daily in the site laboratory, were within normal range.

However, by March 2013, the VFAs started going up beyond acceptable levels on all digesters. The project team had to immediately reduce the loading onto the digesters and stop imports to the site. Importantly, this had to be

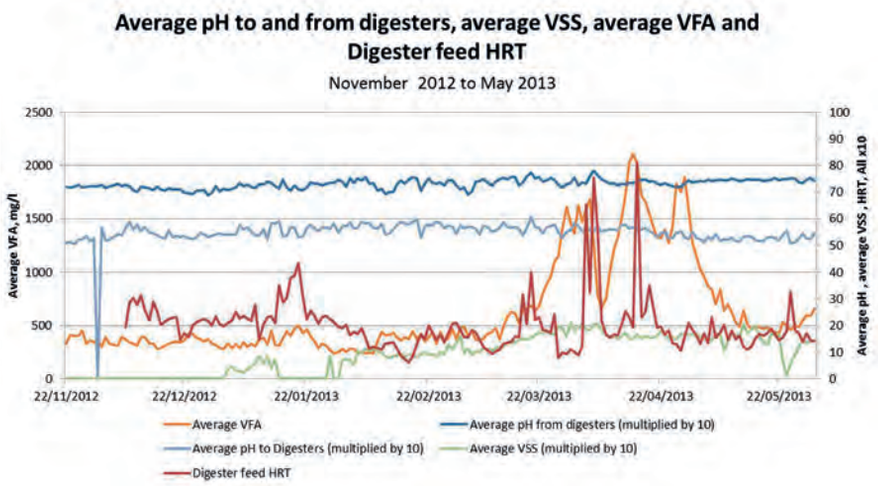

Figure 1: Digester parameters between November 2012 and May 2013

balanced with the necessity to process indigenous sludge so as not to jeopardise the main effluent treatment stream.

Although the VFAs stabilised, foaming within the digesters became more problematic, despite the use of anti-foam. It reached the point where the indigenous sludge load could not be processed through the digesters because feeding was inhibited, requiring the excess sludge to be processed via a temporary mobile centrifuge.

Finding the causes

To review the digester operation, progress investigations and corrective actions, a digester working group was set up comprising technical experts from 4D and Southern Water.

The group's first focus was to identify any possible source of toxicity to the digesters. Some constituents originating from trade effluents or from rainwater run-off can be toxic or inhibitory to the digestion process. As Peacehaven replaced a sea outfall, there was no history of previous biological toxicity so regular analyses to check for heavy metals, hydrocarbons, chloride and VFA speciation were instigated. But the results did not show anything at a possible toxicity threshold value. We concluded the initial toxic source might have been a transitory event which had been missed by sampling. To rule this out, a sludge samples archive of four weeks' worth of digested and feed sludges was set up on site to allow retrospective analysis.

Amenability testing of the various feeds to the digesters was also carried out, first off site at Thames Water R&D facilities, and then on site by setting up six chemostats. These are small-scale laboratory digesters, each with a capacity of 5 litres, enabling testing of different loading conditions. Although the testing did not identify any signs of inhibition, it was instrumental in the decision to reintroduce imported cake and FOG to the site digesters.

It was agreed that if there had been a toxic event behind the initial digester upset, the cause could not be determined and would in all likelihood remain unknown. So our focus turned towards managing the foaming.

Microscopic analyses of sludge samples were carried out in order to establish whether the foaming occurring on the digesters was due to filamentous bacteria and in particular by mycolic acid-forming actinomycetes (MACAs). Although not found to a great degree in the Peacehaven digesters, MACAs were sufficiently rife in the Newhaven WwTW cake to present a concern and cause potential foaming.

"The upside was that the extensive investigations (…) led to new knowledge"

These findings informed our decision to delay reinstating the imports of Newhaven WwTW cake until further contingency measures had been put in place.

Plant management

As well as reactive anti-foam dosing triggered by the charis probes in the digesters, we retrofitted a system to be able to continuously provide a background dose to the digesters. Several anti-foams were trialled on the digesters with HIMARG412 from Surfachem giving the best results.

Following some successful trials on another digester plant at Great Billing, Anglian Water installed a foam breaker as a modification to the mixing system. This helped keep the foaming levels in the digester under control and therefore reduced operating costs.

Cyclical level variations observed in the digesters were assessed to be the result of a small change in sludge density between the core of the digester and the outlet sludge riser. Based on a similar experience in Riverford WwTW, a system was installed, introducing a small amount of air at the base of the riser pipe, in order to decrease the density of the sludge in that pipe and therefore improve the sludge outflow.

It was noted that if the sludge storage exceeded four days prior to feeding, the digesters' gas production was very rapid. This caused digester levels to rise and trigger antifoam dosing. A sludge management regime was therefore introduced to control this.

Result – stable operations

The digesters at Peacehaven WwTW are now operating in a stable manner and processing the design sludge load. Although the root cause of the initial upset is still unknown, the investigations and collaboration of our digester working group unearthed useful knowledge which enabled the team to optimise the operation of the digester.