MOBILE SLUDGE THICKENING: RESULTS FROM ANGLIAN WATER’S SHOP WINDOW

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Abstract

Mobile thickening, where a trailer-mounted thickener performs a ‘milk-round’ service on multiple sites, has potential to make thickening possible on smaller sites, where installing a permanent thickener is not financially viable. By opening the way to thicken on smaller sites, significant costs savings are possible.

The paper presents results from an R&D project where a novel mobile sludge thickener, incorporating the SLG™ (Solid-Liquid-Gas) process developed by Orege (France), was tested in Anglian Water’s Shop Window, centred on the Newmarket sub-catchment in the East of England.

The project was undertaken over a 2-year period and the technology has been successfully used across multiple sites. The project demonstrates the technology can consistently produce sludge of between 5.5 to 7% dry solids, at a polymer dose of 6-8 kg/tds, with a filtrate quality between 500-1000 mg/l.

The project is part of Anglian Water’s Shop Window, which is a microcosm of a future water company, and aims to demonstrate the practical use of new technologies and behaviours.

Key words: Mobile Sludge Thickening, Anglian Water, Orege, Shop Window, sludge, thickening, SLG, municipal sludge, innovation, surplus activated sludge

Introduction

Efficient thickening and dewatering of sludges from sewage treatment remains one of the key challenges for UK water companies. Biological sludge from water recycling is known to have properties that make it difficult to dewater such as high bound water content and compressibility (Sorensen and Hansen, 1993; Katsiris and Katsiri, 1987). In Anglian Water, the preferred approach is either to thicken to a 3 to 6% sludge using a drum or belt thickener, or to produce a 20 to 25% cake using a centrifuge.

In terms of the overall costs associated with operating a Water Recycling Centre (WRC), the cost of sludge treatment and handling is second only to the electricity used for secondary aeration. The majority of this expense is the movement of the treated and dewatered sludge. For this reason, WRC managers are constantly seeking to reduce solids handling costs. A challenge identified by Anglian Water has been how to cost-effectively thicken sludge on small WRCs.

Many plant operators believe this can only be achieved by switching to alternative dewatering equipment. Such a significant change presents additional challenges as a plant operations team is forced to learn an entirely new technology and the facility may incur new operating costs in certain areas (e.g., staffing, energy, maintenance & repair) as they endeavour to reduce polymer usage and increase cake dryness. Treatment plant operators would ideally install new equipment that reduces polymer usage and produces a cake with higher dry solids content; however the high costs of replacing less efficient equipment usually makes complete replacement economically unfeasible. An alternative
approach, presented in this paper, is to utilize existing dewatering equipment, but make it operate more efficiently by adding a pre-treatment step to improve the dewaterability of the sludge.

A new patented technology, developed by Orege in France, called the SLG™ (Solid-Liquid-Gas) process claims to be able to improve the operational efficiency of existing thickening and dewatering equipment. The process acts as a ‘sludge conditioning’ step, upstream of existing equipment, and by changing the characteristics of the solids, *thus* improves Solids Liquid separation and improves its dewaterability.

**Orege SLG technology**

The Orege SLG technology is a proprietary system that uses compressed air to condition sludge to improve dewatering and thickening performance. By injecting compressed air into the sludge colloidal bonds are broken, changing the structure of the sludge prior to dewatering or thickening. This restructuring of the sludge allows for water to more readily escape the sludge during the dewatering or thickening process. Figures 1a & 1b are microscopic views of flocculated sludge with and without the SLG process.

![Microscopic views of flocculated sludge](image)

**Figure 1:**

a) microscopic view of flocculated sludge without the SLG process; and

b) view of flocculated sludge after the SLG process

The restructuring of the sludge is apparent in Fig 1 (above). The colloidal bonds present in the first picture have been broken and the sludge is much more dispersed after the SLG process (second picture). The sludge is much more “open” and free to dewater more readily. There is also much more surface area for polymer to adhere to.
Sludge conditioning and redox potential

The SLG process creates a “floating” sludge that immediately separates water from solids. This separation occurs in a matter of seconds while using up to 40% less polymer. The thickening device capture rate is consistently greater than 95% after the SLG process. This results in a much cleaner filtrate being returned to the head of the plant.

As well as conditioning sludge to improve thickening, the SLG process also claims to reduce the potential for sludge to turn anaerobic, due to the addition of air under high pressure. A common unit used to measure this in wastewater treatment is redox potential.

In wastewater treatment systems, oxidation-reduction potential, or redox potential, is a measurement of the ability or potential of wastewater to permit the occurrence of specific biological (oxidation-reduction) reactions (Gerardi, 2007). For sludge handling, redox potential is a useful measure of the potential for sludge to turn septic which leads to hydrogen sulphide formation and odour problems. For filtrate quality it is useful for understanding the treatability of the filtrate returned to the head of the works. In both cases, keeping redox potential positive, or as high as possible, is beneficial in terms of storage, filtrate quality, dewaterability, and bio-methane potential.

Collaborative development of a mobile sludge thickening solution

Anglian Water is the largest water and water recycling company in England and Wales by geographic area. They are well known for being leaders in innovation, as reflected in their Shop Window initiative which is a flagship for innovation in the water industry. The Shop Window aims to create a view of what Anglian Water’s business will look like in 30 years time.

Thanks to its patented disruptive SLG™ technology, Orège offers efficient solutions for the pre-treatment enhancement of sludge dewatering and thickening operations to industrial, and municipal markets

Founded in 2005 in France with subsidiaries in North America and in the UK, our dedication to innovation and performance improvement has established Orège as the industry leader in sludge conditioning technology.

The mobile SLG sludge thickening configuration developed and piloted in Anglian Water’s Shop Window incorporated the SLG conditioning process on a trailer with a standalone solids/liquid separation device – the Flosep - permanently installed on each site. It is also possible to have the
Flosep incorporated onto a slightly larger trailer where local conditions favour that configuration. Figure 4 below shows the prototype at Newmarket Water Recycling Centre – November 2016.

Large amounts of sludge are currently moved by tanker from smaller water recycling centers to larger sites that have sludge thickening equipment. Using the trailer to take the thickener to the sludge instead could see a significant reduction in tanker movements.

The mobile thickener was first used in Anglian Water’s innovation Shop Window between Newmarket and Soham. The performance indicators for a successful trial were:

<table>
<thead>
<tr>
<th>Performance indicators for trial</th>
<th>Actual performance</th>
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<tbody>
<tr>
<td>Flow: 20m³/h</td>
<td>Flow: 20m³/h</td>
</tr>
<tr>
<td>Dry solids loading: 500 kgDS/h</td>
<td>Dry solids loading: 500 kgDS/h</td>
</tr>
<tr>
<td>Thickened sludge: &gt;5%DS</td>
<td>Thickened sludge: 5.5 – 7%DS</td>
</tr>
<tr>
<td>Filtrate: &lt;800mg/l</td>
<td>Filtrate: 500 – 900mg/l</td>
</tr>
</tbody>
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Results

A summary of results from the trial conducted at Newmarket Water Recycling Centre is shown in Table 2. Providing additional water (final effluent) post-polymer dosing improved the filtrate quality and reduced polymer demand.

Table 2: Results from an initial trial conducted at Newmarket Water Recycling Centre

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Mean</th>
</tr>
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<tbody>
<tr>
<td>FEED (%DS)</td>
<td>2 to 3</td>
<td>2.5</td>
</tr>
<tr>
<td>THICKENED (%DS)</td>
<td>5.5 to 7</td>
<td>6</td>
</tr>
<tr>
<td>FILTRATE (TSS, mg/l)</td>
<td>500 to 900</td>
<td>700</td>
</tr>
<tr>
<td>POLY (kg/TDS)</td>
<td>5.5 to 8</td>
<td>6.6</td>
</tr>
</tbody>
</table>

During the initial trial the filtrate quality was above the target TSS of 800 mg/l. However, as Figure 5 (below) shows, the final 5 samples provided an improvement in both polymer dose and filtrate solids. This was achieved by an additional carrier water at a flow of around 15 l/min being added to the dilute polymer flow. It is thought that this additional volume provided better mixing between the sludge and polymer prior to flotation, giving a better flocculation effect and therefore improved solids capture. Since this initial trial, ongoing operation of the mobile SLG™ performed well with thickened sludge up to 7% DS with no deterioration in filtrate quality. Further ongoing sampling and analysis will be presented at a later date to substantiate current findings around performance.

Results of the trial over the past month are presented in Fig 5 below

![Figure 5: Chronological results of present performance showing polymer dose, filtrate quality, feed and thickened solids](image-url)
Discussion & Conclusions

The project made use of an innovative technology for high-rate sludge separation developed in France by Orege, called SLG (Solids-Liquid-Gas) separation. The sludge is conditioned through the trailer mounted SLG after which it enters a solids/liquid separation vessel (see picture, right) where the thickened sludge and filtrate separate. The proof of concept, covering Newmarket & Soham WRCs, is providing evidence of how this new approach can be used as part of the wider Biosolids Strategy.

References

