water
& SEWERAGE JOURNAL

IWEX 2009 PREVIEW

Issue 1/2009 a Ten Alps publication www.tenalpspublishing.com

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Taking The Industry By Storm

Sewage sludge – challenge or asset?

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The popular perception is that sewage treatment works purify sewage, producing a final effluent that is clean enough to put into a river. From a sludge practitioner's perspective, the view is more that sewage treatment simply converts most of the impurities into sludge, producing final effluent as a by-product. Because of the continual drive to improve final effluent quality, sludge production continues to increase. UK water companies are predicting a rise of around 15% over the next eight years (Water UK) with additional upward pressure from population growth and improved standards of living.

Simultaneously, the options to dispose of sewage sludge have narrowed. Disposal to sea was banned in 1998 under the UWWTD (91/271/EEC) and landfill has been effectively priced out of contention by the UK's application of the Landfill Directive. The principal outlet for sewage sludge is recycling to agriculture. However, the Nitrates Directive (91/676/EEC) and the resultant action programme for nitrate vulnerable zones (NVZ) (2008 revision) have reduced the amount of sludge that may be recycled on agricultural land. Other pressures, such as changes in farming practices; diminishing brownfield landstock; definition of nutrient management under the single farm payment scheme; and ultimately, public perception, are all serving to reduce the land area available for sludge recycling.

While the logic and science behind these pressures is sometimes tenuous, their impact is real enough and has been recognised by the water industry through its voluntary application of the safe sludge matrix (SSM). The SSM was created to protect the agricultural recycling route as it is, more often than not, the most sustainable and lowest cost outlet for sewage sludge. This position continues to be supported by the regulatory authorities in the UK and will probably be the case for the foreseeable future.

Against this background of increasing quantities and reducing outlets, the water industry has adapted in different ways. The first response was to reduce the quantity of

A sludge cake stockpile

sludge to a minimum by incineration or drying. Incineration has changed over the years from a straight thermal destruction process to a more environmentally aware energy from waste (EfW) process, but it remains an unpopular technology with public and planning authorities. Experience has shown that incineration and EfW performance has not lived up to expectations in terms of throughput or electricity production. Despite this, EfW (and, ultimately, gasification) has a role to play in areas where the agricultural outlet is restricted (major conurbations), with appropriate pre-treatment processes improving energy balance and reducing capital cost.

Sludge drying was once seen as a panacea for the water industry. It reduces the volume of sludge, opens a new outlet of energy recovery (in third party outlets such as cement kilns) while preserving the agricultural route. Indeed, it opens up more land because the dried sludge 'enhanced' product can be economically transported further. The carbon footprint of raw sludge drying, however, is the largest of any current sludge treatment process. Re-appraisal of raw sludge drying in the UK water industry has since resulted in nearly all the raw sludge drying plants in the UK being shut down.

So, if incineration and drying aren't the answer, how are water companies dealing with the pressures they face in the sludge arena? The answer is that they are returning to the original sludge treatment process, with references going back to Byzantine times, anaerobic digestion (AD). The resurgence of interest in AD was kick-started by the introduction of Renewable Obligation Certificates (ROCs), which add between 40 and 50 £/MWh to the value of the renewable electricity produced from digester gas. AD occurs naturally whenever sludge is stored. By heating the sludge storage tank to around 35°C and providing adequate seeding and mixing, the sludge is digested by bacterial action to produce a methane-rich biogas. This has a high calorific value (around 23 MJ/m^3) and is easily converted into electricity via a combined heat and power plant (CHP). There are two other significant advantages of AD, the digested sludge is stabilised (i.e. will not putrefy) and sludge mass is reduced. Consequently, it does not give rise to offensive odour and its volume can be reduced by dewatering; factors that help to keep the agricultural outlet open.

The drive now is to enhance AD, to maximise biogas production and minimise sludge mass. In the UK, the current focus is sludge pre-treatment, using processes such as acid-phase digestion (APD) and thermal hydrolysis (THP). APD optimises the two key stages of digestion, hydrolysis and methanogenesis, in separate tanks (or a series of tanks). THP applies the principles of a pressure cooker to considerably augment the hydrolysis stage of sludge digestion. Both APD and THP can increase biogas production, produce a more stable sludge and reduce the pathogenic organisms that define a 'safe' sludge under the SSM. A further benefit of THP is that the digested sludge is dewaterable to a lower volume than is normally achieved; hence THP is currently at the forefront of the considerations of the sewage sludge practitioners in the UK.

Technology is however only part of the picture. Cost and odour have always been important and continue to receive a great deal of attention, but an emerging factor is that of carbon footprint. Work supported by the Carbon Trust has shown that the sludge route is where water companies have the greatest scope to reduce their carbon footprint. To achieve this, the sludge route needs to be considered from production to disposal. When this is done, some process routes appear clearly to be better than others, with the production of renewable energy (from AD) being a major benefit and the use of fossil fuel (in for example, raw sludge drying) an area where improvements should be focused.

Ultimately, in order to take this multiplicity of factors (increased production, reduced outlets, cost, odour and carbon footprint) into account, the water companies are reviewing their sludge strategies and applying the strategic environmental assessment (SEA) approach. This approach not only provides the structure behind the investment and budget planning of the companies, but it is also open to public appraisal and gains major public and regulator relations approval.

While there are many challenges facing sludge practitioners, a balanced approach to sludge management makes it possible to reap the benefits of sludge in terms of renewable energy potential and the value of returning nutrients to agricultural land, so turning the product of sewage purification into an asset.

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