

## SUSTAINABLE SLUDGE MANAGEMENT



Son Le, Treatment Process Development Manager  
United Utilities North West, Lingley Mere Business Park, Warrington, WA5 3LP  
[MS.Lee@uuplc.co.uk](mailto:MS.Lee@uuplc.co.uk); Tel 01925 53726; Fax 01925 537511.

### ABSTRACT

*Agricultural recycling of sludge is recognised as the Best Practical Environmental Option in most circumstances but more can be done to make the practice even more sustainable. With its unique plug flow design Enzymic Hydrolysis, as a pre-digestion treatment process, has brought a step change in pathogen reduction performance while reducing the process time and footprint by half and eliminating greenhouse gas emission from secondary digestion. Average biogas yield increase of 25% over conventional digestion also brings a welcome boost to green energy production. Adherence to the "Safe Sludge Matrix" and HACCP procedures ensures that the UK has the highest standard of health risks control anywhere in the world. Enhanced treated digested cake has provided the opportunity for surface spreading on grassland, even in close proximity to residential areas. Increasingly the ability to produce a low odour product will help to make sludge recycling more acceptable to the public and more sustainable where the land bank is limited.*

### BACKGROUND

Sewage sludge has historically been considered a problematic waste that requires careful management. Traditionally, a significant volume of sludge was disposed at sea or in landfills. Such practices are no longer acceptable. Nowadays the emphasis is very much on recycling and recovering value from sludge. In the UK, agricultural recycling of sludge saves farmers over £8 million in fertiliser replacement value. This is in line with the Government's vision for sustainable waste management and the widely held view that agricultural recycling of sludge is the Best Practical Environmental Option in most circumstances. Europe's Sixth Community Environment Action Programme includes the sustainable use of natural resources and management of wastes (Decision No 1600/2002/EC) and it prompted a revision to Directive 86/278/EEC on the protection of the environment with measures aimed to achieve the long-term goal of 75% recycling of urban sludge to land in the whole of the EU.

Despite its clear benefits, sludge recycling is not without its detractors. Perceived health risks, odour nuisance, heavy metals and organic contaminants are concerns that need to be addressed. Often the fears are based on ignorance of the issues and prejudice of sewage sludge and so communication about the issues is vital. With a long tradition of sludge recycling the UK is leading Europe in sludge management technology and practices. We have been very successful in reducing heavy metal concentration in sludge. Levels of cadmium and lead in particular have been dramatically reduced over the past 20 years. It should also be noted that in certain circumstances heavy metals such as copper are also essential trace elements. Applying sludge as a source of phosphorus can in fact, result in less cadmium being applied to the land than through an application of rock phosphate. The advent of the "Safe Sludge Matrix" and HACCP procedures in sludge preparation ensure that the UK Water industry now operates with the highest standard of health risks control anywhere in the world. None of this, however, means that we can be complacent

since there is always more that can be done; in particular more research is needed to understand the fate of organic contaminants in the soil, their path through the food chain and any possible impact on human health.

## **SLUDGE DIGESTION**

The most common method of sludge treatment is digestion which recovers the energy content as biogas and reduces its odour and pathogen level to make it more suitable for agricultural recycling. Digestion typically involves treating the sludge in a vessel at 35°C for 16 days. Sludge undergoes hydrolysis, acidogenesis and methanogenesis during the process. Since each of the reaction steps involves a different condition, the overall reaction kinetics, pathogen destruction and biogas yield are never optimal. The process must also be completed with a further 14-day period in a secondary digester to achieve adequate pathogen reduction and this could result in the loss of up to 5% of the methane, a greenhouse gas 23 times more potent than CO<sub>2</sub>.

In the UK, it is common practice to combine Primary and Secondary sludge before digestion and this typically produces a volatile solid (VS) destruction rate of about 45%. In recent years there has been an upsurge in the use of two-phase digestion technique, whereby sludge is pre-treated biologically or thermally in order to improve the VS destruction rate. With two-phase digestion VS destruction rate of 50-60% can be expected. This represents an average biogas yield increase of 25%, a welcome boost to green energy production.

## **ENZYMIC HYDROLYSIS APPLICATIONS**

Enzymic Hydrolysis is a form of two-phase digestion. It harnesses the actions of several types of bacteria to accelerate the mineralization process of complex organic matter. The bacteria work by producing and releasing the necessary enzymes, in particular those involved in the hydrolytic reactions. During hydrolysis complex molecules such as carbohydrates, proteins and fats are converted to simpler molecules which may be assimilated by bacteria. This step is usually rate limiting in sludge digestion and by optimising it the VS destruction performance is enhanced.

The Enzymic Hydrolysis process was originally developed as a means for pathogen control to achieve HACCP compliance. Its unique 6-tank design ensures a plug flow profile that has allowed a step change in pathogen reduction performance while reducing the process time and footprint by half and eliminates greenhouse gas emission from secondary digestion. The standard design with 2-day retention at 42°C guarantees 99.9% reduction of *E. coli*. For enhanced treated standard (99.9999% *E. coli* reduction) the last 3 tanks are run at 55°C for maximum pathogen destruction, but allow some of the enzymes to continue working. Operation at 55°C is important, as it would enable any standard CHP scheme to use a greater proportion of the biogas for electricity production. Enzymic Hydrolysis processes have relatively low energy demand and the simplicity of their operation and ability to be retrofitted to existing plants have been widely recognised.

As a biotechnology platform Enzymic Hydrolysis provides further exciting opportunities for resource recycling and process intensification. The use of chemical phosphorus removal with iron toxicity to fish, the significant increase in sludge

volume with its concomitant treatment and disposal cost and the iron shortage poses one of the greatest challenges to the water industry. Recent large scale trials by United Utilities have demonstrated the ability to generate a carbon source with Enzymic Hydrolysis. Such a carbon source should prove ideal for biological nutrient removal and help the industry to relinquish its reliance on chemical treatments.

### **THE BLACKBURN SLUDGE TREATMENT SCHEME**

Blackburn works is a major sludge centre where 13,500 tonnes of sludge per year is treated by Mesophilic Anaerobic Digestion and safely recycled to agriculture. Recent changes in Nitrate Regulations have put severe constraint on the market for liquid sludge spreading on pastures with the high costs of transportation over greater distances and storing of large liquid volumes during closed periods. Consequently, the use of enhanced treated cake was deemed necessary to maintain the land bank for sludge recycling in grassland-dominated North West.

The Blackburn Hydrolyser is a hybrid process that combines the advantage of proven operation of Enzymic Hydrolysis at 42°C with optimum enzyme activity at 55°C to improve VS reduction and biogas yield whilst achieving excellent pathogen control capability at the same time. The project was seen as by the EC as an innovative sustainable solution for sludge treatment and supported by LIFE-Environment. LIFE contributes to the implementation, development and enhancement of the Community environmental policy and legislation as well as the integration of the environment into other EU policies. The plant was commission in November 2005. Comprehensive monitoring of the plant as part of the EC LIFE project evaluation programme was initiated in early January 2006 with a full report on the programme due in 2007.

Cake from Blackburn is recycled mainly within the Fylde area of Lancashire. There are large arisings of animal manures in the area, which is also under the new Catchment Sensitive Farming initiative, and parts are within a nitrate vulnerable zone. Farmers have previously been supplied with conventionally treated sludge cake and limed cake. So far in 2006 the enhanced treated cake has been used as a seedbed fertiliser for maize and cereal crops. Although yield response to all the products tends to be similar, the enhanced treated product has made a significant improvement in odour performance. It has provided the opportunity for surface spreading on grassland, even in close proximity to residential areas. Increasingly the ability to produce a low odour product will help to make sludge recycling more acceptable to the public and more sustainable where the land bank is limited.

### **ACKNOWLEDGEMENTS**

The Blackburn Sludge Treatment Scheme was built with the contribution of the LIFE Financial Instrument of the European Community (project "MAD but better" – LIFE05 ENV/UK/00124).