LIFE – "MAD but better"

Layman's report.

1. Introduction

Every year nine million tonnes of sewage sludge are produced in Europe containing enough energy to meet the electricity and heating needs for 1.7 million homes. The residual solids could also be beneficially used to fertilise half the cereal crops in England and Wales saving farmers over €260 million in fertiliser replacement cost. The trouble is, dealing with sludge is an environmentally sensitive issue.

The application of sewage sludge to land is seen as the most sustainable solution to managing the growing quantities of sewage sludge produced across Europe (see Article 14 of the Urban Waste Water Directive 91/271/EEC) and has more recently received greater recognition for its value in agriculture as a fertiliser to improve soils. However, as a result of perceived risk of contaminants, pathogens, heavy metals and its faecal origin, the use of sludge as an agricultural product continues to remain an environmentally sensitive issue with a significant need to secure public acceptance and build confidence through regulatory compliance.

The LIFE "mad but better" project aimed at developing, implementing and demonstrating a novel full-scale treatment process that would meet the European Commission's aspiration for sustainable development. Specifically the project was designed to show that the process can:

- guarantee a high-quality, safe, soil conditioning product,
- offer sufficient capacity to treat projected future sludge volumes,
- maximise biogas production as an important renewable energy resource.

2. Background

There are many different techniques currently employed across Europe to treat sewage sludge for land recycling including, for example, Mesophilic Anaerobic Digestion (MAD). However each technology has limitations and in particular the inability to guarantee a high enough pathogen kill rate to be accepted Europe wide. Also the existing technologies offer capacity to treat only limited quantities of sludge and the time required for treatment is also too long in process terms.

In recent years sludge treatment has had a new focus aimed at improving product quality, achieving higher pathogen kill rate and looking to treat greater quantities. Treatment of sewage sludge presents a major issue in Europe where it has been the subject of controversy and political discussion. The need to develop and introduce advanced treatment technologies has become clear and was a major discussion point for revision of Directive 86/278/EEC, the main regulation covering the use of sewage sludge in agriculture.

In an attempt to overcome perceived risk, to address concerns about public perception and in anticipation of new, more stringent legislation United Utilities developed the high rate enzymic hydrolysis (HREH) pre-treatment digestion technology. This was designed to be able to be applied to any existing anaerobic digestion (AD) plant; AD being the preferred technology in Europe. The HREH offered the potential to provide the breakthrough in treatment technology to overcome the shortfalls of other existing technologies.

With respect to required sludge cake quality for use as a soil conditioner concerns had been raised from a number of quarters. The UK Government brought the water industry, food producers and other interested parties together to develop and agree a voluntary code of practice; the "safe sludge matrix". This required a quality standard expressed as a level of pathogen kill for:

i) a *conventional* standard (2 log or 99% reduction) considered suitable for application to arable land,

and

ii) an *enhanced* standard of sludge (6 log or 99.9999% pathogen kill and free from salmonella) for application to grassland.

These requirements were very similar to regulations existing in North America.

3. The Enzymic Hydrolysis process.

United Utilities undertook a programme of research in the 1990's which reviewed sewage sludge digestion process characteristics and performance. Some key findings from this work were that the processes were highly influenced by temperature and that in the mesophilic range (at around $40^{o}C$), pathogens, determined through measurement of e-coli, could be effectively eradicated over a two-day retention period. This compared with the conventional 14 days for treatment in Mesophilic Anaerobic Digesters. Figure 1 shows the arrangement for conventional digestion, for enzymic hydrolysis pre-treatment of sludge needed to achieve the conventional safe sludge standard and for the enhanced enzymic hydrolysis pre-treatment process needed to achieve the enhanced standard of the safe sludge matrix.

As well as ensuring that the required quality standard of sludge is achieved the processes provide additional benefit in terms of biogas produced, reduction in volatile organic components of the sludge, reduction in weight of sludge to be transported, better dewaterability and reduced odour.

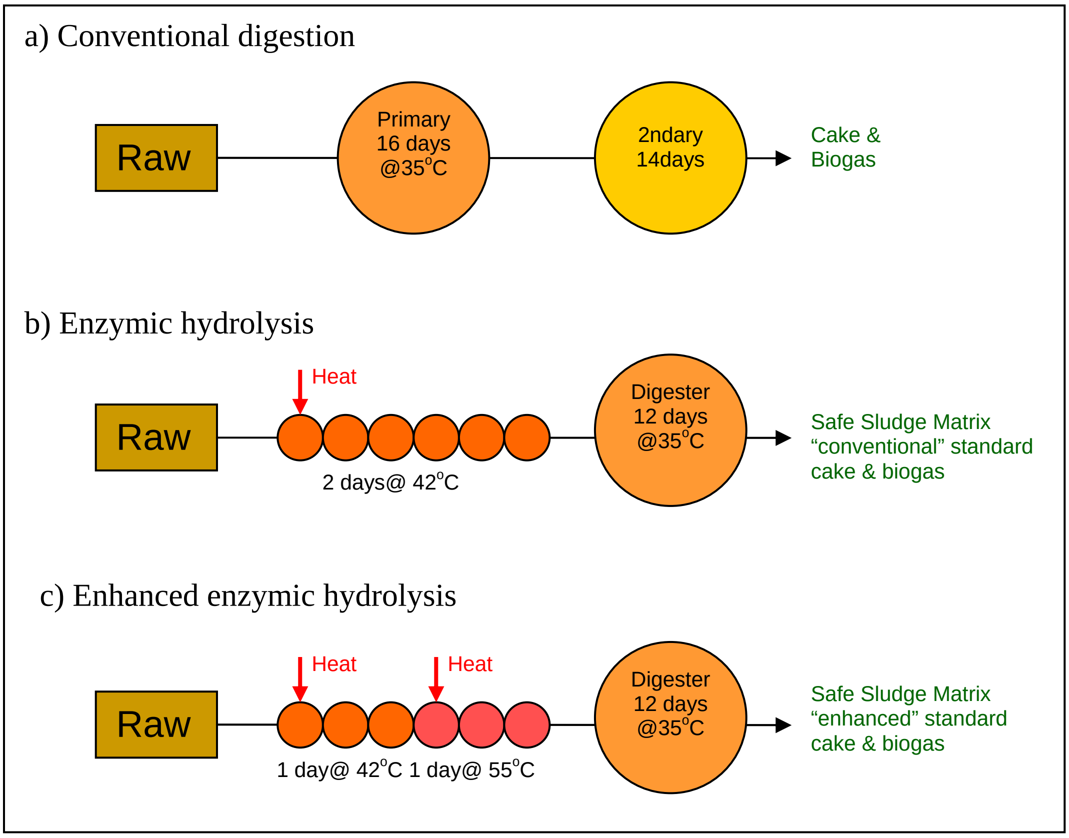

Figure 1 – Process flows for conventional digestion, enzymic hydrolysis and enhanced enzymic hydrolysis.

4. The Plant's performance

The Enhanced Enzymic Hydrolysis process developed and fully implemented at Blackburn with support of the LIFE financial instrument is shown in Figure 2. This shows the six reactor vessels which form the heart of the process with the boiler room and control building to the left and the biogas storage tank to the right. The cooler heat exchanger in the foreground is used to chill the sludge prior to it being pumped into the digesters. (The CHP plant is just out of shot to the left of the picture).

Figure 2 – The built Blackburn Enhanced Enzymic Hydrolysis project

The Blackburn site has successfully demonstrated that the required quality standard of sewage sludge can be achieved consistently and in a robust manner. Figure 3 shows the quality performance of the cake produced by the Blackburn Enhance Enzymic Hydrolysis project. The plant was run in conventional standard mode for the first few days and it achieved a reduction from raw sludge with a content of $4x10^6$ e-coli cfu / gDS to $4x10^3$ e-coli cfu / gDS. Once the enhanced mode had been brought into operation levels of e-coli became undetectable; this performance has been maintained to date (Aug 2007). It should be noted also that the cake has very low odour and in a survey of farmers it has shown to be highly acceptable and because of low odour could be readily applied in locations near to housing.

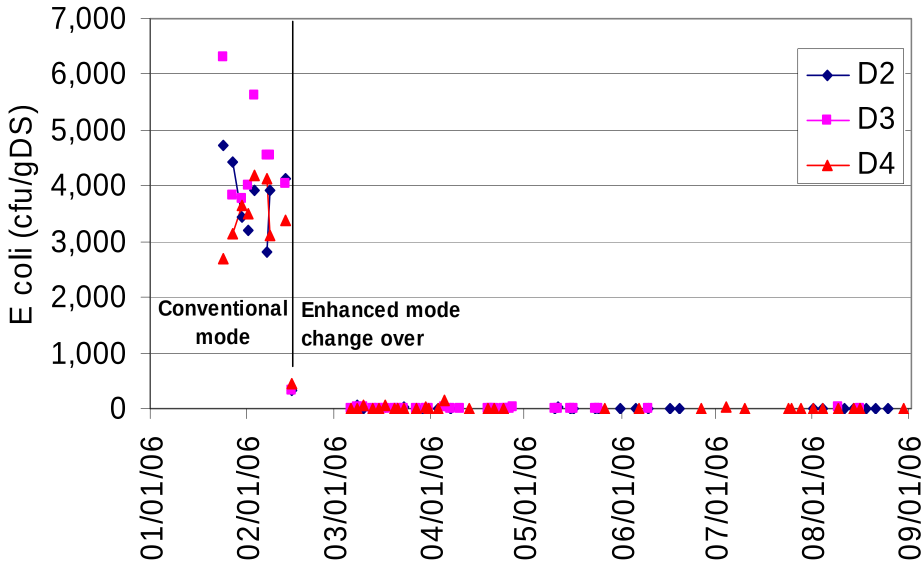

Figure 3 - Quality of Blackburn Cake.
(Note that D refers to measures at different digesters of which there were four at Blackburn)

The optimisation of the Enhanced Enzymic Hydrolysis plant at Blackburn also demonstrated that additional biogas is produced by the process.

The Blackburn project has also successfully demonstrated that Enhanced Enzymic Hydrolysis can be readily fitted to existing wastewater treatment works. Furthermore Blackburn wastewater treatment works takes a number of wastes from nearby wastewater plants as well as industrial effluents including food waste. This provides confidence that the process could be readily applied to other waste streams such as municipal waste and that this could be used to produce biogas and soils conditioning fertilisers. Figures 4 to 6 show production and use of sludges and the combined heat and power plant.

5. Dissemination

Dissemination was a key aspect of the project both in informing regulators, water industry, energy industry and agriculturalists about the process and its capability as well as securing public confidence in the use of sewage sludge in agriculture. Those visiting the plant included water engineers and scientists from regulatory bodies and from water companies, energy technologists as well as farmers and members of the public. During the completion and implementation of the Blackburn Enhanced Enzymic Hydrolysis project some 250 visitors had been to the site. These visitors were from 26 different countries around the World and 12 European countries. A visitor centre was established on the site and a brochure was provided in English, Polish and German language.

AnoxKaldnes was a partner in the project and is a leading research and development company based in Lund, Sweden. As such the company had been involved with development of new technologies for treatment of water, soil and air and in ensuring that these were commercialised and made available. Anox Kaldnes was included in the project and its evaluation as it could bring an independent high-level understanding of biochemical processes involved with sewage sludge treatment and it would be able to evaluate and report on the process performance.

Dissemination would continue beyond the LIFE project by involvement with presentation of technical papers at conferences and by hosting visits to the site.

United Utilities has also looked at scaling the plant down to enable it to meet the need of small rural communities as well as for industries which produce energy rich streams that could be exploited (e.g. food, pharmaceutical, paper).

By mid-2007 four plants had been built and commissioned by United Utilities and five plants had been ordered by other UK water companies three of which were being commissioned by August 2007. Interest was also being shown from countries outside the UK.

Figure 4 Digested sludge cake

Figure 5 Spreading cake to land

Figure 6 Combined Heat and Power (1MW capacity)

Figure 6 Wheat grown on sewage sludge fertilised land

United Utilities acknowledges support of the LIFE Financial Instrument in its support for the project.