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Biological effluent treatment boosts profits

Sweet smell of successful anaerobic digestion at British Sugar plc

Wastewater

case study 9

The benefits of installing an anaerobic digester to treat high COD wastewater at British Sugar include:

- Effluent treatment cost savings equivalent to £800,000/year*
- Potential savings equivalent to £73,000/year* by using biogas as a fuel
- Low-maintenance, compact equipment
- Odour-free technology

"I recommend any company that produces biodegradable wastewater to look at anaerobic digestion as a cost-effective and environmentally sound technology."

Robert Brookes,
Senior Process Engineer,
British Sugar plc

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British Sugar plc

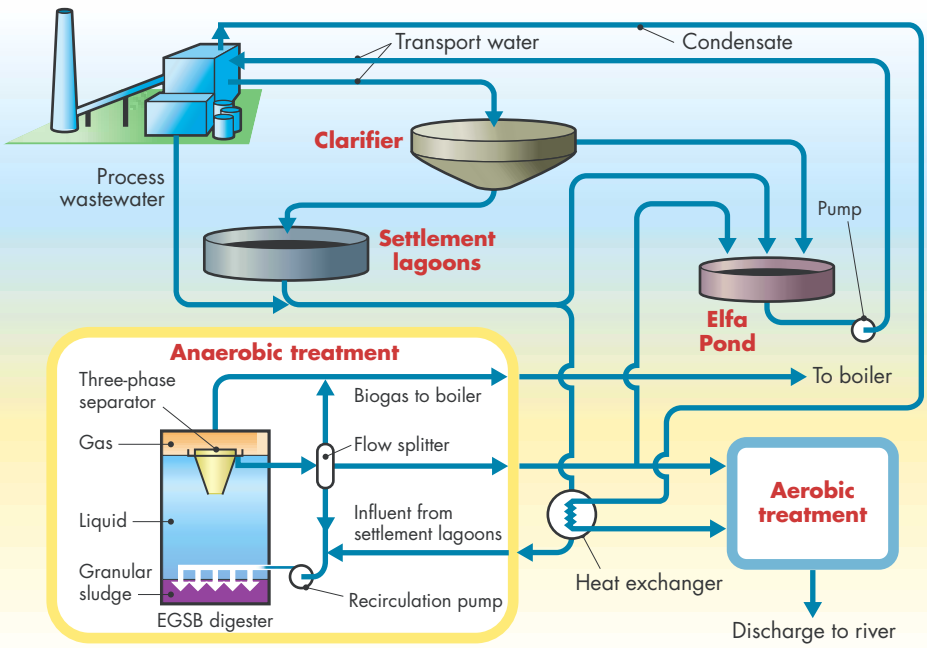
company profile

British Sugar plc operates seven factories throughout the UK and produces about 1.3 million tonnes/year of white sugar from sugar beet. The sugar is sold to industry in various grades and particle sizes or as treacles and syrups for use in food and drink processing. The processing season, known as the 'campaign', usually lasts from September until the end of February. The York factory where the anaerobic digester is installed employs over 100 people.

Background

Sugar beet is transported into the factory along a water-filled flume. The water also removes mud and allows the removal of stones, weeds and other debris. The dirty transport water flows into a clarifier where the mud settles at the base of the vessel (see Fig 1). The mud slurry is pumped to settlement lagoons and the clarified water flows to the 'Elfa Pond' for re-use as transport water. The mud slurry contains sugar leached from the beet. To meet discharge consent limits, the mud slurry requires treatment to reduce its chemical oxygen demand (COD) prior to discharge. Processing the sugar beet also produces condensate containing ammonia.

Fig 1 Main elements of the new water handling system at British Sugar's York factory



In 1995, British Sugar increased the feed rate of sugar beet to the York factory by 30% from 7,000 tonnes/day to 9,100 tonnes/day of sugar beet. This led to a corresponding increase in the volume of wastewater requiring treatment. The existing treatment system, which consisted of an aeration system with discharge to sewer, did not have the capacity to treat the extra wastewater. British Sugar decided to investigate alternative biological systems to see if it was possible to treat all of the wastewater sufficiently to permit discharge to river. The Company also wanted to tackle other problems with the site's existing water-handling system. For example, the lengthy retention times in the settlement lagoons had led to odour problems and acidity due to sugar breakdown. These acids had to be neutralised with lime, incurring additional costs.

Biotechnology Options

For British Sugar, the advantages of anaerobic digestion over aerobic treatment included:

- reduced sludge production
- ability to treat higher COD loads
- faster treatment with lower energy costs
- production of biogas as a by-product.

Therefore, British Sugar decided to install an anaerobic digester upstream of the existing aerobic system, which was retained to 'polish' the effluent by removing residual COD and to remove the ammonia from the condensate before discharge to river.

British Sugar considered a contact digester, an upflow anaerobic sludge blanket (UASB) digester and an expanded granular sludge bed (EGSB) digester (based on the UASB technology). The EGSB system was chosen because it had the smallest footprint for the same treatment rate (see Table 1). This allowed the digester to be installed in a confined space close to the factory and existing services, thereby minimising additional piping and electrical costs. The unit cost £1.5 million, including installation, commissioning costs and refinements to the aerobic system.

Table 1 Key properties of the anaerobic digesters considered

Type of digester	COD load (tonnes/day)	Active volume (m^3)	Diameter (m)	Total height (m)
Contact	16.63	3,696	17.5	17
UASB	16.63	1,386	15.0	9
EGSB	16.63	723	8.5	15

Anaerobic Digestion at British Sugar

Wastewater from the settlement lagoons is heated to 37°C (the optimum temperature for anaerobic bacterial treatment) and pumped into the bottom of the digester where it passes up through a bed of granular sludge (the biomass). The biogas, biomass and treated water are separated at the top of the digester by a three-phase separator (see Fig 1). The biogas is pumped to a boiler for use as fuel, while the biomass settles back into the active area (the granular sludge bed). The treated water is recycled back to the digester to maintain a constant wastewater flow. Approximately 50% of the effluent leaving the digester is recycled to the Elfa Pond for re-use as transport water and the rest is treated in the original aerobic system before discharge to river.

The EGSB digester was started using granular sludge imported from another digester and has been fully operational since the end of 1996. The digester removes about 12 tonnes/day of COD and has an average removal efficiency of 80% (see 1999 campaign data in Fig 2).

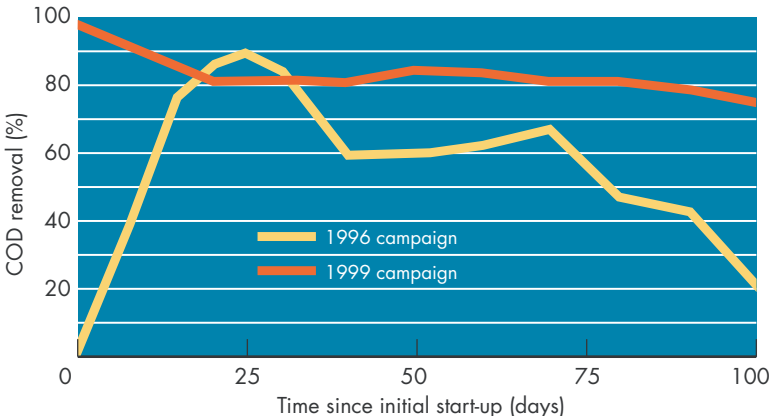
An unanticipated problem was calcium in the influent to the anaerobic digester. Although lime was not added to the transport water, lime from the sugar process found its way into the influent to the digester. This led to a build-up of calcium in the biomass, which altered the properties of the granular sludge and reduced the efficiency of the digester (see 1996 campaign data in Fig 2). The problem was resolved by carrying out simple changes to the pipework to reduce the amount of calcium carbonate entering the digester.

Lessons for Success

Key lessons from this Case Study are:

- compact digesters are now available that allow on-site treatment where space is at a premium
- investigate the chemical composition of the influent and make sure it is compatible with the biomass
- use of sludge from another digester permits fast start-up
- use of the biogas by-product as a fuel yields cost savings.

Fig 2 Performance of the EGSB digester



Benefits

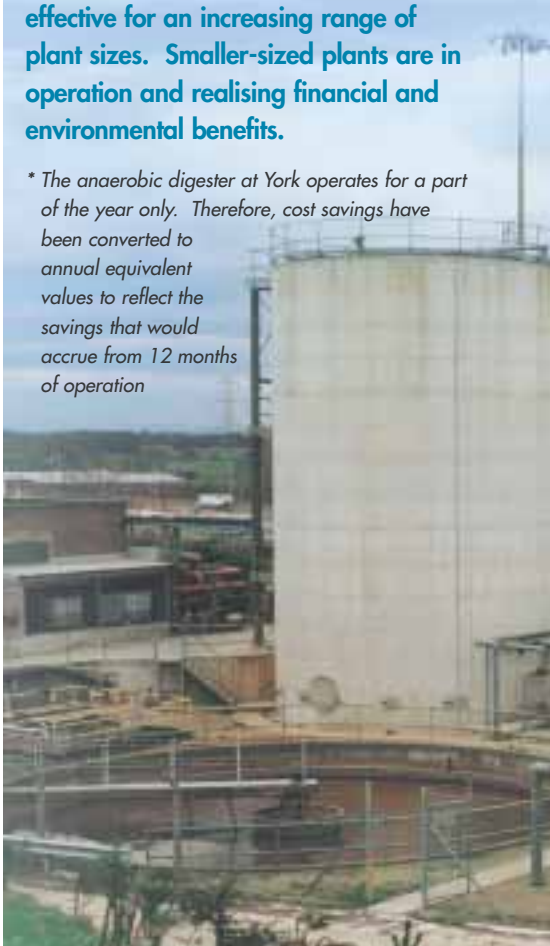
The effectiveness of the biological treatment system means that the final effluent can now be discharged to river. British Sugar estimates that it would have cost over £800,000/year (annual equivalent*) in trade effluent charges to discharge the same volume of wastewater to sewer. Burning the biogas on site as a boiler fuel instead of using natural gas has the potential to save a further £73,000/year (annual equivalent*), giving an overall payback period for the plant of about 21 months.

Environmental benefits include less sludge waste, the elimination of odours and the ability to deal with higher COD loads. Recycling treated water within the water handling system has reduced acid levels in the lagoons, alleviating the need to add lime.

Anaerobic digestion can also be used to treat high-strength wastewaters from industries such as brewing, chemicals, paper manufacture, fermentation, potato processing and soft drink production.

Technical developments mean that anaerobic digestion is becoming cost-effective for an increasing range of plant sizes. Smaller-sized plants are in operation and realising financial and environmental benefits.

** The anaerobic digester at York operates for a part of the year only. Therefore, cost savings have been converted to annual equivalent values to reflect the savings that would accrue from 12 months of operation*



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Comments from British Sugar plc

The EGSB digester has proved to be very effective in treating factory sugar effluent in a digester only one fifth of the volume traditionally used by British Sugar. I recommend any company that produces biodegradable wastewater to look at anaerobic digestion as a cost-effective and environmentally sound technology.

Robert Brookes, Senior Process Engineer

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Further Help

Contact the BIO-WISE Helpline for free, independent information and advice about wastewater treatment and/or other types of biotechnology. BIO-WISE can provide access to expert advice from around 30 UK Industrial Biotechnology Specialists. These specialists can provide up to four hours of free advice and show you where biotechnology could add value to your business.

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