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Sustainable Management of Foul Water

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Environmentally sound treatment of wastewater, whether on a specific site or via a public treatment works, can be a way to have a positive impact on energy consumption, carbon footprint, nutrient balance, quality of our watercourses, pollution content in public rivers and much more.

Current Provision

A significant portion of the wastewater from residential and commercial developments is currently managed by a dedicated public foul water sewer system (underground pipes), finally discharging into a public treatment plant. To give an idea of the scale of the infrastructure, a 2002 document by DEFRA indicates that every day in the UK about 350,000 kilometres of sewers collect over 11 billion litres of wastewater. This is then treated at about 9,000 sewage treatment works across the country.

However, not all of the UK is served by the dedicated foul water network. Some areas (such as central London) are served by a combined sewer system (that manages both surface and foul water, still with discharge to a treatment plant) and some areas are not served by any infrastructure and so manage waste via cess pits, septic tanks, and treatment units. While the issue with combined sewers (and their overflows) has been well documented and received a lot of media attention recently, this article will look closer at treatment and what happens to the treated effluent.

The Rules for Sites

Cesspits, cesspools, and septic tanks are often alike in construction, and none are connected to the main sewer system. Unlike septic tanks, cesspools and cesspits do not include a treatment system. Septic tanks of old are now often marketed as foul water treatment units and offer a measurable degree of water treatment.

Under a new code of practice introduced by the Environment Agency, people now have a legal responsibility to minimise the impact of their sewage waste if they manage it within the bounds of their property. This was implemented in the Environment Agency Binding Rules (England, DEFRA, January 2015). As a side note from this legislation, homeowners with septic tanks that discharge directly into ditches, streams, canals, rivers, surface water, drains or any other type of watercourse will need to replace or upgrade their drainage either when they sell their property or as soon as possible under this guidance.

This guidance also specifies that all septic tanks (treatment units) that currently ultimately discharge into watercourses will have to be replaced using a sewage treatment plant with full BS EN 12566-3 Certification. As an alternative to this (if the tank is not to be replaced), the discharge to the watercourse can be stopped and diverted to a new drainage field, designed, and constructed to the current British Standard BS6297 2007. This option will depend on the viability of infiltration on the site.

Sustainable Treatment Options

There is potential for the organic matter contained in wastewater from our sewage systems to become a resource with large scale energy from waste systems. When organic waste decomposes in an oxygen-free environment, it releases methane gas. This methane can be captured and used to produce energy, instead of being released into the atmosphere.

Sewage treatment systems begin treating wastewater by separating and collecting the solid sludge. In a sludge-to-energy system, this sludge then undergoes a pre-treatment process called thermal hydrolysis to maximize the amount of methane it can produce.

The treated waste then enters an anaerobic digester, which finishes breaking it down. The resulting product is a methane-rich gas, or biogas, that can be used for on-site energy needs, or processed further and used in place of natural gas. In addition, the solid remnants of the waste create a nutrient-rich “digestate” that can be added to soil to boost plant growth.

A 2015 report by the World Research Institute found that one sludge-to-energy plant in China produced enough compressed natural gas to meet the daily energy requirements of approximately 300 cars. Although this is not considering the energy demand of the plant itself.

The goal of having public treatment plants as net energy producers is realistic, if not yet achieved. Wastewater already contains between two and four times the amount of energy required for the wastewater treatment process and so there is huge potential for energy efficiency and creating net zero water treatment.

Reducing energy consumption and increasing the efficiency of energy production are both required to have positive energy treatment plants. According to this Frontiers article, potential measures to reach this goal include:

Process optimization: installing smart meters, developing control systems for the optimal operation of aeration systems and water pumps. In wastewater facilities, an estimated 10–20% energy savings can be achieved through a better control and optimization of the process.

Enhanced biogas yield: currently, anaerobic digestion biogas can only provide around 50% of the total energy consumption. However, sludge pre-treatments can lead to an increase of the biomethane yield.

Efficient on-site combined power and heat generation: the use of fuel cell systems can increase further the on-site electricity generation.

Co-digestion of sludge with food waste is also an interesting option to increase the overall biogas output.

There was a UK target for treatment plants to have 15% of their energy consumption from renewable sources by 2020. However, only a portion of this (90% recorded in 2002) comes from the sludge processing.

Things are starting to change with a project in Wales given the green light in November 2020 to convert sewage into zero emission fuels for vehicles as one example, but there is a significant investment required in treatment works to make them more efficient in the UK. Net Zero wastewater treatment is achievable, but there is a lot of work to do.

Dealing with Sludge

Sludge can contain both compounds of agricultural value (including organic matter, nitrogen, phosphorus and potassium, and to a lesser extent, calcium, sulphur and magnesium), and pollutants which usually consist of heavy metals, organic pollutants and pathogens. The characteristics of sludge depend on the original pollution load of the treated water, and on the technical characteristics of the wastewater and sludge treatments carried out.

Sludge is usually treated before disposal or recycling to reduce its water content, its fermentation propensity, or the presence of pathogens. Several treatment processes exist, such as thickening, dewatering, stabilisation and disinfection, and thermal drying. The sludge may undergo one or several treatments as part of the overall process.

Once treated, sludge can be recycled or disposed of using three main routes: recycling to agriculture (land spreading), incineration or landfilling. Other, less developed outlets exist, such as silviculture, land reclamation, and other developing combustion technologies including wet oxidation, pyrolysis and gasification.

For the sludge to be used in a more efficient and environmentally sound way, the treatment process must be refined to suit its end use. With correct treatment, the sludge can be converted into a mineral rich product that will benefit agriculture and the environment. This is already being actioned by some water companies, under the guidance of Ofwat.

Small Scale

While the above processes are being implemented at a large scale on public treatment works, the technology is difficult to scale down without becoming cost inefficient. Having a wastewater treatment unit on a new development is the sustainable option but would normally be immediately dismissed if there is a public sewer to discharge to. The costs outweigh the benefits significantly, so the installation of foul water treatment is not practical currently.

Some companies are advancing the technology of their treatment units to be low (or zero) power consumption and are investigating ways to implement management of the treated water and sludge to provide energy and reduce carbon footprint.

Currently almost all treatment units need to be de-sludged on a regular basis and the sludge is not able to be re-purposed on the site itself. Treatment unit providers should investigate new ways to manage the output of their systems to see if any re-use is possible. For example, there is increased research in the field of microbial fuel cells. This is a form of renewable energy generated during the wastewater treatment process. This is a bio-electrochemical process that aims to produce electricity by using the electrons derived from biochemical reactions catalysed by bacteria. While the technology is still in its infancy, it is anticipated that it can supply enough energy to partially cover the electrical demand of the treatment unit.

New technology and innovation could be the key to having a private treatment unit provide energy and useful by-products that can be re-used. While this technology does exist, the challenge is to produce it on a scale that is workable and provides a net benefit to the site, without having an industrial monstrosity sat in someone's back garden.

Summary

The wastewater treatment sector is catching onto the possibility that wastewater can be processed in such a way to provide significant benefits in the form of energy, pollution reduction, re-useable by-products, and total carbon offset.

It's fair to say that the UK falls behind some other countries in this field, with significant investment and development required to convert all the existing plants to be more efficient.

On a small scale, there are options to hand, but many are too expensive to implement or maintain to be a viable solution currently in new developments.

References

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Zero emission energy from sewage project gets green light

Ofwat Bioresources Market