

Biological treatment continues to be the “bread and butter” technology for the European wastewater treatment equipment market

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Overview – Resurgence of biological technology



The European biological wastewater treatment equipment market has seen resurgence in recent years. This has largely been on account of both the stringent discharge limits under the EU Directives, particularly of nutrient levels, as well as the advances in biological wastewater treatment such as better treatment efficiencies, which are being embraced by both municipal and industrial customers.

The biological wastewater treatment equipment segment comprises a group of technologies used in secondary wastewater treatment. These technologies are based on processes which employ aerobic or anaerobic microorganisms and result in decanted effluents and separated sludge containing microbial mass together with pollutants.

Biological treatment methods dominate the secondary wastewater treatment sector as it is the most effective and eco-friendly option of the available treatment processes. The demand for the biological wastewater treatment equipment is on growth path which is catalysed by the need to meet obligatory wastewater treatment standards, imposed by environmental legislation to municipalities and industries in the vast part of developed countries.

The main advantages of biological wastewater treatment are as follows:

- Low capital and operating costs compared to alternatives such as chemical-oxidation processes
- True destruction of organics, versus mere phase separation, such as with air stripping or carbon adsorption
- Oxidation of a wide variety of organic compounds
- Removal of reduced inorganic compounds, such as sulphides and ammonia, and total nitrogen removal possible through denitrification
- Operational flexibility to handle a wide range of flows and wastewater characteristics
- Reduction of aquatic toxicity.

EUROPEAN UNION REGULATIONS FOR MAIN END-USERS SEGMENTS

Europe represents around one-third of the world’s environmental market and is driven by the European Union (EU) environmental regulations that are among the toughest in the world. For the biological wastewater treatment market two EU directives are crucial: Urban Wastewater Treatment Directive (UWWTD- 98/15/EEC) issued on 21st May 1991 and the Integrated Pollution Prevention and Control (IPPC-96/61/EC) Directive.

Each of them refers to different segments of end-users in the wastewater market:

- UWWTD – to municipal end-users
- IPPCD – to industrial end-users.

The Urban Wastewater Treatment Directive requires that agglomerations meet minimum wastewater collection and treatment standards within fixed deadlines.

These deadlines are fixed according to the sensitivity of the affected waters and to the size of the urban population concerned. Furthermore it identifies so called Sensitive Areas as the areas that have to be put upon the special treatment.

Every Member State had to classify its areas as sensitive or non-sensitive based on conditions specified in the Directive until the end of 1993, and since then have had to review its list of Sensitive Areas every 4 years.

Key requirements of the Directive are that collecting systems and secondary treatment must have been provided for all agglomerations more than 10,000 population equivalent (p.e.) by the end of 1998 and for all municipalities of more than 2,000 p.e. by the end of 2005. In cases when discharge is to a Sensitive Area, more stringent than single secondary treatment is required – in this case nutrient reduction in the form of advanced biological wastewater treatment.

The second - the IPPC Directive - in essence is aimed at minimising pollution from various industrial sources throughout the European Union. It imposes on the member states an obligation of controlling operators of certain industries to reduce pollution and properly manage their wastewater treatment with appropriate measures. Operators of industrial installations covered in the Directive are required to obtain an authorisation (an environmental permit) from the authorities in the EU countries. To obtain the permit one must assure that:

-All appropriate preventative measures are taken against pollution, in particular through application of Best Available Techniques (BAT).

-Waste production is avoided and where waste is produced, it is recovered. Or where this is not technically and economically feasible it must be disposed of avoiding or reducing the impact on the environment:

- Energy and materials are used efficiently.
- Necessary measures are taken on the closure of an installation to avoid any pollution risk and return the site to a satisfactory condition.
- The IPPC Directive indicates the Best Available Technique for each industry and so raises the necessity of new investments for many industrial operators, especially since the deadline for compliance – October 2007 - is fast approaching.

For some sectors, the use of biological wastewater treatment techniques will be a must, like for food & beverages industry - as for high level of nutrient in high volumes of wastewater discharged, the membranes bioreactors (MBR's) seem to be one of the best treatment solutions. For the food & beverage industry, this kind of treatment may not only minimise nutrient contamination of wastewater but in some cases result in valuable by-products recovery that can be used in further industry processes. Thus it follows IPPC Directive's stress on cost reduction and material efficiency which in that case is acquired by opportunity of water reuse.



Large scale MBR unit from Zenon.

The other industry that can benefit from biological processes in wastewater treatment is the petrochemical industry that needs more complex systems to remove carbonaceous and nitrogenous pollutants. Some of the leading equipment manufacturers provide innovative biological solutions designed for treating petrochemical industry wastewater, the best examples include Petro MBR developed by Siemens Water Technologies and customised MBRs from Zenon of GE Water & Process Technologies.

Nevertheless, the European Union's concern in the environment is very strong and this comes along with the equal concern to minimise restraints for industrial development and economic growth. That is why the project CADOX, Coupled Advanced Oxidation-Biological Process for Recycling of Industrial Wastewater Containing Persistent Organic Contaminants, has been initiated. The project is supported by the European Commission under the Fifth Framework Programme and it's aimed at seeking for cost effective, modern, safe and efficient technologies but minimising the necessity of banning some substances that are important for the industries' development. Its final output is meant to be in the form of a closed loop hybrid technology based on integrating Advanced Oxidation Processes (AOPs) driven by Solar Energy and Biological Processes.

Although Europe takes a leadership role in environmental protection, biological treatment solutions have become more popular and more commonly used technologies in less developed countries that haven't adopted or presently have restrained environmental legislation but for economic reasons (such as the tourism industry) want to protect their water resources.

As most conventional biological treatment solutions are simple technologies using natural resources and/or some mechanical treatment, they are affordable for many even less financially capable end-users.

TECHNOLOGY INSIGHT

Regarding construction and space placement we can distinguish 3 main types of plants for biological treatment:

- Aquatic systems
- Terrestrial systems
- Mechanical systems

Aquatic and terrestrial systems are used when suitable land is available and the mechanical ones usually when smaller space may be used or there is a need for more advanced solution.

The most common aquatic system technology is facultative lagoons. It uses both aerobic and anaerobic processes - the water layer near the surface is aerobic while the bottom layer, which includes sludge deposits, is anaerobic. There are also aerated lagoons - smaller and deeper than facultative ones.

The aeration devices in both kinds of lagoons can be mechanical or diffused air systems. The chief disadvantage of lagoons is high effluent solids content.

The terrestrial treatment systems as septic tanks or constructed wetland depend upon physical, chemical, and biological reactions on and within the soil.

They produce little or no discharge at all. Their main advantages are conditions of maintenance and operating – low in costs and easy to perform. Some of them (like septic tanks) may be used in households.

The mechanical systems still use the biological and physical processes but with use of mechanical devices such as series of tanks, along with pumps, blowers, screens, grinders, and other mechanical components.

Second classification refers to the type of processes in the wastewater treatment. Trickling Filters, Rotating Biological Contactors, Sequence Batch Reactors, Powered Activated Carbon are all mechanical systems.

Regarding biological wastewater treatment technologies and types of processes, we can classify treatment equipment in 4 groups:

- Aerobic processes or systems
- Anaerobic processes/systems
- Membrane Bioreactor Systems (submerged and external loop systems)
- Innovative biological treatment systems

Aerobic systems treat wastewater using natural processes that require oxygen. Bacteria that thrive in oxygen-rich environments work to break down and digest the wastewater inside the aerobic treatment unit. Like most onsite systems, aerobic systems treat the wastewater in stages. Sometimes the wastewater receives pre-treatment before it enters the aerobic unit. Treated wastewater leaving the unit requires additional treatment (passage through a soil absorption field) before being returned to the environment.

Anaerobic wastewater treatment takes place without the use of air or elemental oxygen. Many applications are directed towards the removal of organic pollution in wastewater, slurries and sludges. The organic pollutants are converted by anaerobic microorganisms to a gas containing methane and carbon dioxide, known as "biogas". The dominating output is gas with a little sludge while aerobic processes produce a lot of excess sludge and no biogas.

Membrane Bio-Reactor (MBR)

Among mechanical technologies at present, Membrane Bio-Reactor (MBR) technology is the most advanced biological treatment option widely available. It combines a biological reactor with advanced membrane filtration and represents the most rapidly growing membrane technology in the water sector.

Membrane bioreactor systems combine a conventional biological process with the membrane technology. Compared with the conventional activated sludge process, membrane bioreactor technology has a better performance in water treatment applications because of high sludge concentration, high pollutant removal efficiency, low production of excess sludge and simple operation and facility management. MBRs produce superb quality effluents (solids free, up to 99% reduction of organic pollution, effective treatment of N & P compounds), in an efficient way and with relatively low operational costs.

With increasing numbers of populations connected to wastewater treatment systems, the amount of sludge is growing and becoming a real trouble for the wastewater sector.

'Conventional' biological wastewater systems, in which the sludge is separated from treated effluents by sedimentation, are limited in their ability to produce high quality effluents. As the sludge has to be somewhere disposed, it raises the threat that pollution will be just transferred from wastewater to the soil. The MBR technology diminishes the amount of disposed sludge and minimizes the side effects of wastewater treatment.

MBR technology is currently the most expanding technology on the market as it meets the need for more efficient, more compact and easy to operate solutions than conventional ones but there are some other new technologies that appeared on the market.

Innovative biological wastewater treatment systems

The increasing popularity of MBR makes the way for further innovative solutions meeting the need for high efficiency combined with low operational and maintenance cost as well as construction flexibility (smaller footprint and compact solutions) but on the other hand capable of dealing with complex contaminations and making wastewater ready for reuse. The ones worth mentioning are Biological Aerated Filtration Systems and Attached Growth Air Lift Reactor.

In terms of Biological Aerated Filtration Systems, BIOFOR® is an innovative biological wastewater treatment system launched a few years ago by Ondo Degremont. It's a high-rate, up-flow biological fixed-film system that acts as a biological contactor as well as a filter, thus eliminating the need for a separate clarification step. Its advantages over the conventional methodologies are as following:

- elimination of secondary clarifiers
- small footprint
- fully automated operation; minimum operator attention required
- treatment of cold and dilute wastewaters
- capable of handling wide flow and temperature variations
- rapid start-up

Another innovative technology is Attached Growth Airlift Reactor - AGAR® launched by Siemens Water Technologies. It uses thousands of special carriers designed to create an enormous total surface area for biofilm growth – enhancing wastewater treatment process without expanding footprint. The process can be operated as either a fixed-film only or an integrated fixed-film activated sludge (IFAS) process. Benefits of AGAR® system are as following:

- improved oxygen transfer
- reduced maintenance and operating costs;
- allows for expansion/upgrade without additional tankage;
- nitrogen removal without increased hydraulic retention time

Summary

The biological treatment equipment segment has dominated the wastewater treatment equipment market over the past decade with aspects such as nutrient removal and sludge reduction gaining increasing acceptance among both municipal and industrial customers.

The challenge in the European biological wastewater treatment equipment market is for the established players to preserve or better still to consolidate on their market shares in an increasingly competitive market segment. Companies that are looking to venture into the biological wastewater treatment segment and companies that are going to expand in terms of product portfolio or regional coverage would be better advised to understand the market dynamics of these technologies and variation in opportunities across regions to better realise the results of their business development strategies.

Therefore the focus would be on seeking for new solutions and investing in research to provide high efficient technologies on the one hand - meeting regulatory standards, on the other - reasonable priced - will be crucial to win the opportunities of the market.

For more information on our current and ongoing work in the wastewater treatment market, please contact us.