INDUSTRIAL WASTE & WASTE WATER MANAGEMENT IN PHARMA INDUSTRY

Pharmaceutical industry wastewater varies enormously in flow and composition, depending on factors such as the production rate, the specific preparation being carried out, which activities are generating the waste water, etc. All these variables mean that the pollution of the final effluent can be very diverse and variable over time. Generally, this wastewater contains:

- A high content of organic matter, a large part of which is easily biodegradable (alcohol, acetone, etc).
- Slowly biodegradable organic compounds and refractory substances (aromatic compounds, chlorinated hydrocarbons, etc).
- Inhibiting and toxic compounds (antibiotics).
- Soaps and detergents with surfactants.

The best techniques for treating the effluents generated by this type of industry will depend on each specific case, given their considerable variation and the wide range of possible compounds. The following discusses the techniques that may be the most competitive according to the various factors, giving the advantages and weal points for each.

Activated sludge biological process

Although this is the most competitive process for waste water with easily biodegradable organic matter, because of the possible presence of inhibiting and toxic compounds for the biomass and the low biodegradability of some effluents produced, it is not the most recommendable process. However, if the pollution is biodegradable, it is a simple and efficient process.

Moving bed biofilm reactor process (MBBR)

When the waste water is compatible with a biological treatment and the content of organic matter is high, MBBR is beyond doubt the most efficient option. This technology consists of the growth of biomass as a biofilm on plastic supports that are continuously moving in the biological reactor. These supports have a high specific area per unit of volume, which allows more biomass to flow per unit of volume than in conventional reactors. MBBRs do not have the bed clogging problems due to excessive biomass growth as occur in fixed bed systems and the system is considerably more efficient compared to a conventional system because the biofilm that forms on the walls of the support is more effective than biological flocculants. Considering that the support's particles have a high specific area, MBBR reactors are also much smaller than those using activated sludge. Another additional advantage is that the process can be divided into various stages with a specific biomass growing in each, adapted to the pollutant load in the feed current. This flexibility allows more persistent compounds to be broken down. This technique is viable only when the pollution is biodegradable.

Mechanical steam compression vacuum evaporators

When the waste water pollution is complex and a biological process is not viable (presence of persistent, inhibitor or toxic compounds, low biodegradability, etc.) or its nature varies greatly over time, the vacuum evaporation of the water with the mechanical compression of steam is a very efficient, robust, simple and accessible option with low energy costs. The steam is compressed mechanically to raise its temperature to provide superheated steam which gives up its energy in a heat exchanger to heat the water to be evaporated while the steam itself condenses. By working in the vacuum, the boiling point and steam temperature range from 60 ºC to 90 ºC.

This alternative goes beyond the simple objective of satisfactorily treating effluents, since the flow of waste water is converted into a concentrated pasty residue (minimizing the amount of residue generated) and clean water which can be treated for re-use, this attaining the optimal scenario of sustainability with zero discharge.

Anaerobic digestion process

When the waste water contains a high concentration of biodegradable organic matter with no toxic or inhibitor substances, treating it with a process of anaerobic digestion can be efficient and economic. Since it is anaerobic it not only saves the aeration of the process but also generates biogas that can be converted relatively easily into heat and electricity.

Advanced oxidation process

When the waste water contains a high concentration of persistent compounds (chemically very stable) or toxic substances, cases with very low biodegradability, processes are needed that are more intensive for destroying the pollutants. Advanced oxidation refers to a wide range of technologies most of which are based on generating hydroxyl radicals or on supplying the energy needed to destroy the polluting molecule. These techniques are especially competitive for eliminating halogenated hydrocarbons (benzene, toluene, phenol, etc.), detergents, dyes, etc. The most common of the wide range of available techniques are electro-chemical oxidation, catalytic ozonation, anodic oxidation, the combination of ultraviolet radiation and hydrogen peroxide, Fenton's reagent and photo catalysis. All of these are techniques that can eliminate high loads and can attach any pollutant thanks to their non-selective nature. However, they are expensive techniques so that they are reserved for those cases in which the chemical destruction of the pollutant is the only answer.

To summarize, when the pollutants are organic and easily biodegradable, both the moving bed biofilm reactor (MBBR) and the anaerobic processes can be good options. When a biological process is not viable, vacuum evaporation is a robust, efficient, versatile and competitive option. Despite their high efficiency and non-selectivity, advanced oxidation techniques are reserved for applications in which the flow to be treated is low, due to the cost involved. Generally, the optimal treatment option will depend on each case and the collaboration of an expert company will be needed to study and design the most appropriate process for each case.

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