

Treatment and management of industrial wastewater

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Abstract

The terms: "pollution prevention", "waste minimization", "source segregation" and "in-plant control", have been increasingly mentioned over the past decade in conferences and projects related to industrial wastewater management. While end-of-pipe treatment of industrial wastes was a popular management approach only 20 years ago, advanced treatment/management concepts are more common today. These attitudes may reduce the waste quantity and improve its quality for further treatment and disposal. Thus the overall cost of the manufacturing product (including production costs and treatment/disposal expenses) may be reduced and environmental nuisances and hazards can be minimized. An in-plant control program may be an economical strategy for complex and toxic wastes such as in the chemical or petrochemical industries, which employ individual in-plant biological treatment. It is also a proper alternative for industrial wastewater which is destined for a biological treatment at a publicly owned wastewater treatment (POWT) plant. In-process pretreatment technologies, applied on a small-scale for specific contaminants, may eliminate the need for large-scale and sophisticated treatment processes, and may ensure the success of a conventional biological treatment for a pre-segregated bio-treatable stream. Pretreatment should be based on a preliminary source segregation aimed at classification of source streams. In this approach, it is crucial to identify toxic/refractory and toxic/inhibitory substances. Identification of heavy metals in waste sources is relatively simple, since they are process-specific and are easy to monitor. There is a difficulty, however, in regard to toxic organic substances, since complex industrial wastes contain a high variety of compounds with a wide range of properties. Application of rapid and convenient toxicity screening methods (such as the Microtox™ assay) may be practical for simple characterization and classification of waste sources. Source segregation can result in the classification of three groups of waste sources: (a) Streams containing readily biodegradable organics with low toxicity. These may not require any pretreatment, and can be included in the main biological treatment. Further bench-scale and/or pilot-scale testing of biological treatability of the newly designated "bio-treatable stream" is recommended; (b) Streams containing highly volatile organics. These are problematic streams to be pretreated by a controlled in-process stripping for further recovery or destruction of solvents; (c) Streams possessing extreme toxicity and/or poorly biodegradable organics. These are the most problematic streams, management of which may require process modifications and/or local stream-specific pretreatments such as carbon adsorption or chemical/thermal oxidation. Activated carbon adsorption is considered an efficient process with high selectivity for toxic compounds, however, the sorbed contaminants should be further treated or disposed in landfills. Catalytic wet oxidation (CWO) is a method for the treatment of diluted aqueous waste streams containing a variety of complex organic pollutants. It can be used to mineralize organic contaminants to CO₂/H₂O or to convert them into nontoxic and biodegradable products to be further treated by a conventional biological treatment. The presentation will review alternative technologies for industrial wastewater treatment, demonstrate a simplified protocol for characterization of raw production waste streams, and analyze several case studies (pesticides, brominated flame retardants, munitions, phenols, and dairy wastes).