Gaseous and Solid Waste Treatment Cost Estimation

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Abstract

Waste produced in chemical processes is a growing concern for the chemical process industry. In general, the industry was slow to comprehend the issue of waste treatment in the early years of industrialization, which tended to spawn processes with limited regard for waste products, and weak understanding of long term consequences. As the implications for waste generation and accumulation grew, environmental concerns began to pressure the industry for better treatment systems and disposal problems. The growing pressure and regulation push the industry to minimize wastes and improve treatment methods. Ideally, zero discharge is the ultimate target, but most processes cannot live up to that goal. Until such time, as all processes have been improved to eliminate all wastes, waste treatment will remain a required segment of the industry.

Gas, liquid, solid, and water waste streams each have different treatment methods. PEP Report 295 (December 2016) reviewed the methods for wastewater treatment, and treatment techniques for solid sludges resulting from the wastewater treatment systems. This report addresses similar methods for gaseous wastes and non-wastewater based solid wastes. Liquid wastes other than wastewater may be treated by some of the same methods evaluated in this report or PEP Report 295, with minimal adaptation.

Gaseous waste treatment methods include absorption, adsorption, dust collection, chemical reaction, combustion, and physical property adjustment. Absorption methods involve solvent scrubbers, water scrubbers, and venturi scrubbers to capture components of a gas stream by a liquid. Adsorption methods cover selective capture of gas stream components on a bed of solid particles. Dust collection separates particulate dust entrained in a gas stream using fabric filters, cyclones, or electrostatic precipitators. Chemical reaction alters other methods to enhance the intended behavior of a technique by chemically altering the substances in the stream, like caustic scrubbers to absorb acid gases. Combustion systems destroy components in a gas stream to ash and slag for mineral content and carbon dioxide and steam for organic species. Physical property adjustment involves unit operations to change temperature and pressure of the gas, generally for subsequent treatment.

Treatment methods for solid waste streams include physical separation for storage, conversion, or destruction. Separations include screening, gravity settling, flotation, filtration, and centrifugation. Precipitation and crystallization form the solids to be separated, which may be supplemented by chemical reaction. The nature of the solid waste components determines the type and configuration of the treatment methods, which may be inorganic salts, insoluble organics, sludges, or tars. Destruction methods involve incineration of the waste. PEP Report 295 already covered centrifuges, dryers, microfiltration, and ultrafiltration separation techniques for wastewater sludge; however, each method is adaptable to general solid waste materials. Circulating bed combustion and fluidized bed incineration were also previously evaluated for wastewater sludge destruction, but they are also adaptable to general solid waste treatment.

This report reviews 29 gaseous waste treatment methods and 10 solid waste treatment systems. The solid treatment chapter also discusses adapting 6 of the evaluations from PEP Report 295 to evaluate the routes for a wider array of solids. Each of the methods have been revised and updated to supply incremental cost contributions of individual waste treatment systems, such that they can be used to incorporate an estimate of waste treatment for a process as part of the conceptual design and economic evaluation.

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