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Project Summary

Process Design Manual for Stripping of Organics

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Procedures and correlations for designing and costing stripping towers for the removal of organics from aqueous streams are presented. The emphasis is on practical methods suitable for engineering estimates. The designs cover steam strippers with and without condensers and reflux, as well as air stripping. Steam stripping is treated as an isothermal process and simplified equations for determining tower height may be used. Determination of the height adiabatic air strippers involves a tedious, iterative solution of heat and material balances. A BASIC computer program for carrying out these calculations is provided.

Capital costs are determined, essentially, by estimating the quantity of materials required in conjunction with material costs. Cost factors for a range of materials and installation factors are suggested. Methods for costing ancillary equipment such as heat exchangers, pumps, compressors, and storage vessels are included. It is recommended that vendor quotes be obtained wherever possible. Typical operating costs for energy and maintenance are also given.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Stripping is one of several processes used commercially for separating organics from water and wastewater. The selection of the optimum process for any given application is dependent on the characteristics of the organics as well as on other factors including cost and the need to recover the separated organics.

In the case of a mixture of organics having different properties, two or more treatments in series may have to be provided. The use of two different processes, for example, one with cost dependent on throughput, followed by a polishing step having cost dependent on feed concentration, can result in a lower overall treatment cost. In a wastewater treatment train, stripping is typically the first process that separates dissolved substances. It follows clarification or filtration steps that are used for removal of suspended solids and may precede polishing steps such as carbon or resin adsorption.

The essential characteristic that determines the effectiveness of stripping in separating dissolved organics is the relative volatility or vapor pressure of the organic above the aqueous phase. It has been shown that at least half of the 186 organics on the USEPA's toxic pollutant list are sufficiently volatile to be effectively removed from aqueous waste streams by stripping. Sixty-eight of these can be very easily stripped by air at ambient temperatures. Others can be stripped by air at ambient temperatures with steam. The remaining substances on the list have relatively low vapor pressures and are not easily stripped.

Stripping is emerging as a cost-effective alternative for treating a wide range of aqueous streams containing organics. It may be used both as an in-plant process for the recovery of organics from relatively concentrated aqueous streams and as an end-of-pipe treatment for removal of dilute and even trace quantities of organics from wastewaters prior to discharge

or recycle. Steam stripping is typically used for in-plant separation, whereas air or steam may be used for end-of-pipe treatment, depending on the volatility of the organics and post-treatments provided. In addition, air stripping is being increasingly used for the removal of trihalomethanes (THMs) and trichloroethylene (TCE) from drinking water supplies.

Purpose

The purpose of this manual is to provide, within a single document, both data and procedures for designing and costing stripping systems for organics separation. A major objective was to develop and summarize simplified and practical engineering procedures of study grade accuracy. The designs and costs obtained are suitable for evaluating the feasibility and viability of stripping relative to other control technologies and for checking commercial designs. They are not intended for detailed or definitive designs.

Scope

The design procedures cover:

1. Tray and packed towers
2. Air and steam stripping
3. Live and reboil steam
4. Refluxed and non-refluxed steam stripping
5. Isothermal and adiabatic operation
6. Continuous operation
7. Ancillary equipment including heat exchangers

The design and cost procedures are summarized in a stepwise fashion to facilitate their routine use. Procedures for using the simplified analytical equations appropriate to most stripping applications are demonstrated by means of a worked example. A BASIC program suitable for desk-top computers is provided for the case of adiabatic air stripping where the usual simplified equations are less reliable. A comprehensive review of the theory of stripping and the development of the design equations is also included. Although the manual is not intended as a text, the reader may find the background material useful as a refresher course in stripping. We recommend that all users scan the background sections, particularly with reference to the limitations on the procedures and data.

The process design is oriented towards single-component relatively dilute systems. Other systems can nevertheless be handled as well. For example, multicomponent systems can be sized by designing for the least volatile organic, and then determining the distribution of the other components separately. Use of the simplified design correlations for concentrated streams may result in errors due to thermal effects and deviations from vapor-liquid equilibrium correlations. The more rigorous design equations may, however, be used without difficulty provided the necessary enthalpy and equilibrium constant data are available.

The design of ancillary systems such as decanters and other vapor handling equipment is specifically not handled. Multiple towers and batch stripping are also not treated. Maintenance and operational problems are not discussed, and controls, instrumentation, and civil design are not covered. The cost of these items is nevertheless included in the budget estimates.

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The complete report, entitled "Process Design Manual for Stripping of Organics," (Order No. PB 84-232 628; Cost: $14.50, subject to change) will be available only from:
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5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
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