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Project Summary

Costs of Air Pollution Abatement Systems for Sewage Sludge Incinerators

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Capital and operating costs were calculated for applying six different air pollution control systems to municipal sewage-sludge incinerators that were using multiple-hearth furnaces. The systems involved three principal types of air pollution equipment—wet scrubbers, fabric filters, and electrostatic precipitators—applied to three different plant sizes (plants incinerating 36, 72, and 300 tons of dry sludge per day in one, two, and eight multiple-hearth furnaces, respectively). The six options were (1) venturi/tray scrubber with a 40-in. pressure drop, (2) fabric filter system operating at 500°F and equipped with an upstream temperature control, (3) fabric filter system operating at 500°F and equipped with a heat exchanger and a scrubber for SO_2 reduction, (4) electrostatic precipitator (ESP) with upstream limited temperature and humidity control, (5) same as Option 4 but with an additional downstream wet scrubber for SO_2 reduction, and (6) ESP with upstream temperature control and an SO_2 scrubber.

Results indicated that all three types of controls could achieve a total particulate removal efficiency of 99 percent but that the venturi/tray scrubber option entailed the lowest capital cost and the highest annual costs.

This Project Summary was developed by EPA's Water Engineering 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

In the United States, wet scrubbing devices are normally used to control particulate emissions from multiple-hearth furnaces designed for incinerating sewage sludge from municipal wastewater treatment plants. Fabric filters and electrostatic precipitators (ESP's) offer possible alternatives to wet scrubbers. This report evaluates the feasibility and associated costs of using these three control devices.

Budget estimates were made for six different system configurations involving three primary control devices, a sulfur dioxide (SO_2) scrubber, and ancillary devices (e.g., heat exchangers) for application at three different sizes of municipal sewage sludge incineration plants (i.e., plants processing 36, 72, and 300 tons of dry sludge per day and using one, two, and eight multiple-hearth furnaces, respectively).

The report presents the feasibility of using each of the three control devices, the process for selecting a control system, cost data, and detailed costing methodology.

Emission Control System Characteristics

The following factors must be considered when judging the practical applicability of an emission control system for sludge incinerators:

- The high degree of particulate removal required (99 percent in this study).
- The presence of condensable fumes (requires that gas be cooled as much as practical).

- The temperature of the gas entering the control equipment.
- The high moisture content of the gas.
- The presence of acid gases (such as chlorides).

Wet Scrubbers

Wet scrubbers (generally venturi or impingement type) have traditionally been used to control particulate emissions from multiple-hearth incinerators. Though they have achieved compliance with emission standards at many incinerators and have reduced odor problems, their power requirements are high.

Fabric Filters

Fabric filters are used widely for particulate control in the metallurgical industry, where hot gasses and fine fumes are encountered. A large fabric filter system could be used at sludge incinerators if emission gasses could be cooled to at least 500°F. Cooling could be accomplished by water spray or air dilution. A smaller system could be used if the gas were cooled to 200° to 300°F, but some moisture condensation might occur. Fabric filter systems are rather large, however, and they do not remove odors.

Electrostatic Precipitators

High-voltage ESP's have successfully collected both solid and liquid particulate matter from smelters, steel furnaces, petroleum refineries, cement kilns, acid plants, and many other operations. These devices can be operated in the wet or dry mode (i.e., above or below the gas dewpoint). Power consumption is low on dry ESP's; but corrosion resulting from acid gases can be a problem, and the system does not reduce odors. Wet ESP's also have low power consumption. In addition, they remove acid gases and soluble material and reduce odor problems.

Cost Estimates

Table 1 summarizes the capital and annual costs for all six options at the 36-, 72-, and 300-mgd plants. The costs are based on an arrangement in which each incinerator has its own captive air pollution control equipment (i.e., two identical systems are required at a plant with two incinerators, and eight identical systems are required at a plant with eight incinerators). The capital cost evaluations reflect the cost savings of having more than one identical system installed.

Conclusions

Technical feasiblity studies indicated that all three types of controls (wet scrubbers, fabric filters, and electrostatic precipitators) could theoretically achieve the goal of 99 percent particulate removal.

The venturi/tray scrubber option entailed the lowest capital cost, but annual costs were highest for this option because of the pressure drop (40 in. of water) thought to be necessary for 99 percent particulate removal resulted in high energy costs. The advantages of the wet scrubber are that it cools gas to 120°F, achieves compliance with emission standards, removes acid gases and other soluble material, and reduces organics and odors. The venturi/scrubber has been used for most sewage sludge incinerators and has a history of success.

The fabric filter with the sulfur dioxide scrubber system has a capital cost double that of the venturi/scrubber system and an annual cost nearly as high. This system is known to provide excellent particulate removal; however, the high moisture content and temperature changes associated with a multiple hearth sewage sludge incinerator could easily cause a mud pack to be formed on the bags and make the bags inoperable. Also, other research on a side stream from an incinerator indicated particulate material was not removed by the shaker system used to clean the bags, and it was necessary to brush the fly ash from the bags before returning the bags to service.

The electrostatic precipitator preceded by a sulfur dioxide removal system had a capital cost double that of the scrubber system, but had a lower annual cost than the venturi/scrubber system. Although this system (wet ESP) appears to have the same capability as the scrubber/venturi system, it does not have a proven record of performance.

Both the wet ESP and fabric filter systems should require a backup scrubber system (in both cases, the sulfur dioxide scrubber system) to ensure that the incinerator can be operated with a pollution abatement system if the primary system fails.

The full report was submitted in fulfillment of Contract No. 68-03-1821 by James M. Montgomery Consulting Engineers, Inc. under the sponsorship of the U.S. Environmental Protection Agency.

Table 1. *Capital and Annual* Costs for Plants with One, Two, and Eight Multiple-Hearth Furnaces+ (in thousands of mid-1985 dollars)*

		Option 1— venturi/tray scrubbers		*Option 2— fabric filter*		*Option 3— fabric filter and SO_2 scrubber*		*Option 4— ESP*		*Option 5— ESP followed by SO_2 scrubber*		*Option 6— ESP preceded by SO_2 scrubber*	
Plant size tons dry sludge/day	*Number of incinerators*	*Capital costs*	*Annual Costs*	*Capital Costs*	*Annual Costs*	*Capital Costs*	*Annual Costs*	*Capital Costs*	*Annual Costs*	*Capital Costs*	*Annual Costs*	*Capital Costs*	*Annu Cos*
36	*1*	*$1,007*	*$ 595*	*$1,484*	*$ 547*	*$ 2,062*	*$ 547*	*$ 1,850*	*$ 404*	*$ 2,055*	*$ 484*	*$ 2,112*	*$ 4*
72	*2*	*1,757*	*1,141*	*2,598*	*781*	*3,613*	*1,018*	*3,243*	*740*	*3,601*	*881*	*3,701*	*8*
300	*8*	*6,448*	*4,452*	*9,531*	*2,463*	*13,247*	*3,895*	*12,074*	*2,828*	*13,408*	*3,375*	*13,781*	*3,4*

**Consists of direct operating and maintenance costs and indirect costs including capital recovery.*

+Options 3, 5, and 6 have an additional scrubber for SO_2 control. Gas flow from each incinerator is 19,053 scfm or 94,469 acfm at 1142°F. Avera moisture content is 39.12 percent. Capital recovery costs are based on 10 percent interest rate and a useful life of 10, 20, and 20 years for vent scrubbers, fabric filters, and electrostatic precipitators, respectively.

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The complete report, entitled "Costs of Air Pollution Abatement Systems for Sewage Sludge Incinerators," (Order No. PB 87-117 743/AS; Cost: $13.95, subject to change) will be available only from:
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