United States
Environmental Protection
Agency

Risk Reduction
Engineering Laboratory
Cincinnati, OH 45268

Research and Development

EPA/600/S2-89/016 Jan. 1990

EPA

Project Summary

Baghouse Efficiency on a Multiple Hearth Incinerator Burning Sewage Sludge

R. C. Adams, L. E. Keller, E. V. Robb, M. C. Vancil and Joseph B. Farrell

A pilot-scale fabric filter (baghouse) was evaluated for its performance in removing 23 metals and sulfur as well as total particles when fitted to a multiple hearth incinerator burning sewage sludge. The small-scale baghouse was installed to take a slipstream of about 3% of the total incinerator emissions. Particle size fractions were collected from the gas streams entering and leaving the baghouse. Each particle size fraction was analyzed for the 24 elemental species, and baghouse performance was evaluated for overall removal efficiency, size fraction removal efficiency, and for selective removal of specific metals. Total concentrations of each element in the controlled emission stream were determined as well as the proportionate concentrations of species in the solid and volatile states. Concentrations of each metal in the emission stream were compared with the concentrations in a sludge residue. To obtain comparisons of baghouse performance with a more typical emission control device, the performance of the incinerator's full-scale wet scrubber was also evaluated.

The efficiency of the baghouse for collection of total particles was 99% compared with 94% for the wet scrubber system. Its collection efficiency was superior for cadmium, but the wet scrubber was much more efficient for collection of sulfur.

This Project Summary was developed by EPA's Risk Reduction Engineering 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

This research project was undertaken to determine the particulate removal efficiency of a fabric filter emissions control system installed on a multiple hearth furnace burning sewage sludge. Of particular interest was the fate of metals found in a city/industrial type of sludge when incinerated and subjected to fabric filter (baghouse) air pollution control. A pilot-scale baghouse was temporarily fitted to an existing multiple hearth furnace burning digested and dewatered sewage sludge. A slipstream of incinerator exhaust gas, amounting to about 3% of the total incinerator exhaust, was taken from the top hearth of the incinerator. This afforded an opportunity to compare baghouse performance with the particulate removal performance of the incinerator's wet scrubber.

Procedure

The full-scale, six hearth, multiple hearth incinerator was fitted with ducting to take a slipstream of uncontrolled emissions. The slipstream was fed to the baghouse at temperatures averaging 411°F. The top hearth temperature of the incinerator averaged 747°F during baghouse operation.

Emission tests were first conducted at the inlet and the outlet of the incinerator's

wet scrubber; these were followed by tests of the baghouse performance. A Source Assessment sampling train (SASS) was used to collect particle size fractions of diameters of >10 μm (micrometer), 3 to 10 μm, and <1 μm. To collect volatile metals, impingers (bubblers) were located downstream of the particle sizing part of the train. The impingers were immersed in an ice bath. A weak solution of nitric acid was used to facilitate capture of the metals.

Metals were analyzed by the inductively coupled argon plasma method (ICAP). The concentrations of 23 target metals plus sulfur were determined in each particle size fraction and in the impinger catches. From these results, concentrations of each metal in the controlled and uncontrolled emission streams, in each particle size fraction, and in the impinger catches were determined, as were overall efficiencies of the emission control devices and removal performance of the individual metals and the specific particle fractions.

Results and Discussion

In addition to assessing the fate of the metals in the uncontrolled and controlled emissions from the incinerator, the baghouse and the scrubber system were compared. The devices were not tested simultaneously, which lessens the value of the comparison, but differences were so great that results can be viewed with confidence. The baghouse proved to be much more effective for removing total particulates than did the scrubber system. Baghouse efficiency averaged 99.1% for the three baghouse runs whereas the average efficiency for the scrubber runs was 94.3% (Table 1). An examination of collection efficiencies for individual particle size fractions shows that the scrubber was inefficient in collecting particles finer than 1 μm; the baghouse was efficient for all fractions. Both devices showed 100% efficiencies for the 3-μm and 1-μm catches. This does not necessarily reflect their performance for these fractions. For an unknown reason, the uncontrolled emissions contained very little mass in these size fractions. Because recovery downstream of the air pollution control devices was negligible for these fractions, efficiencies were calculated as 100%.

Contamination reduced the value of the results for several elements, most particularly chromium and aluminum. Effects of contamination were most pronounced for the controlled emissions because mass collected for the SASS train fractions was small and a small amount of contamination produced a large effect. Contaminants in the filter paper affected results for several metals in the <1 μm catch, and dissolution of stainless steel contaminated the impingers (bubblers) as well as the "probe + 10-μm" catch. Only results unaffected by these problems are reported below.

Uncontrolled particulate emissions showed substantial enrichment for three metals: cadmium, lead, and tin. These metals also were present in unusually high proportion in the finest fraction (<1 μm). These metals may volatilize during combustion and condense to fine particles or adsorb on the finest p leaving the incinerator.

In the controlled emissions, ca removal efficiency averaged 82% wet scrubbing system and 98.5% baghouse. Efficiency was low for t scrubber because the scrubber eff was low for the <1 μm filter fraction, and most of the cadmium this fraction.

The enrichment ratio for ca increased from 25.6 for uncon emissions to 75.4 at the scrubbe and to 47.1 at the baghouse outl concentration of cadmium in the fraction combined with poor col efficiency for the finest fr accounted for the large increa enrichment ratio for the scrubbe increase was not as large fc baghouse because collection effi for the finest fraction was only lower than that for the other fraction

The scrubber showed a 99% re for sulfur whereas the baghouse re very little sulfur. If SO_2 remo important, a baghouse would have preceded or followed by at least pressure drop wet scrubber.

Visual observation showed a c plume, which indicated significant o emission, and condensation of a layer on surfaces. Pressure drop the filter bags rose slowly durin tests, indicating that the bags requ more vigorous cleaning procedure baghouse supplier noted that samples from the bag were high in volatiles" (water and/or volatile o compounds).

Table 1. *Particulate Removal Efficiency by SASS Size Fraction*

	Probe + 10 μm	*3 μm Cyclone*	*1 μm Cyclone*	*Filter Catch*	*Total*
Baghouse					
Run 6	*99.3760*	*100.0000*	*100.0000*	*97.7570*	*99.4660*
Run 7	*99.1470*	*100.0000*	*100.0000*	*98.7090*	*99.4300*
Run 8	*97.3230*	*100.0000*	*100.0000*	*99.4260*	*98.4180*
Average	*98.6150*	*100.0000*	*100.0000*	*98.6310*	*99.1050*
Scrubber					
Run 2	*94.7800*	*100.0000*	*100.0000*	*54.6930*	*91.9460*
Run 3	*98.9140*	*100.0000*	*100.0000*	*64.2670*	*95.7600*
Run 4	*99.3110*	*100.0000*	*100.0000*	*58.3740*	*95.1460*
Average	*97.6680*	*100.0000*	*100.0000*	*59.1110*	*94.2820*

clusions and ommendations

e superiority of the baghouse over wet scrubber system for collecting particles and most metals was ly established. On the other hand, et scrubber system collected sulfur h more efficiently than did the ouse.

The colored plume, an oily layer on some surfaces, and the presence of "early volatiles" in the dust collected on the filter bags indicated the presence of a substantial proportion of unburned hydrocarbons, which could adversely affect the long-term performance of a baghouse. Use of an afterburner would obviate this problem, but if an afterburner were not to be used, a long-term test of a bag filter would be advisable to verify that the filters would not be clogged by oily discharges.

The full report was submitted in fulfillment of Contract No. 68-03-3148 by Radian Corporation under the sponsorship of the U.S. Environmental Protection Agency.

R. C. Adams, L. E. Keller, E. V. Robb, and M. C. Vancil are with Radian Corp., Research Triangle Park, NC 27709. The EPA author, ***Joseph B. Farrell,*** *is also one of the EPA Project Officers (see below)*

Howard Wall *and* ***Joseph B. Farrell*** *are the EPA Project Officers (see below).*

The complete report, entitled "Baghouse Efficiency on a Multiple Hearth Incinerator Burning Sewage Sludge" (Order No. PB 89-190 318/AS; Cost: $28.95, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officers can be contacted at:

Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

EPA/600/S2-89/016