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Project Summary

Characterizing Baghouse Performance to Control Asbestos Manufacturing Source Emissions

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This study is part of a research program designed to improve the effectiveness of airborne asbestos fiber removal by baghouses. A typical fabric filter baghouse control system, shown in Figure 1, was automated and modified to facilitate the use of the EPA Method 5 sampling train, shown in Figure 2 to monitor the output of the baghouse during the commercial fabrication of asbestos containing materials. Single-point near isokinetic inlet samplers were installed on each of four inlet ducts. The baghouse mass loadings, the outlet fiber concentrations, and operating conditions of the fabrication process were monitored. Each of three operating parameters of the baghouse was observed at three levels. The baghouse research parameters were shake amplitude, shake duration and shake interval.

Two test series were conducted. The first was a statistically designed test series, the results of which were interpreted using multiple linear regression analysis on the 1/3 factorial test design. The linear regression analysis showed shake duration to be the most important parameter, followed by the shake amplitude and the shake period. The results indicated that, at optimum shake interval and shake duration, a 5-fold improvement in asbestos fiber emission control was achieved. The second test series was run to determine whether extending shake intervals would produce an equivalent 5-fold reduction in fiber emissions, and if the mass loading or waste type were more significant characteristics. Extending the shake intervals did result in low emissions; however, no significant effect on control was achieved by extending shake duration. No detectable change in pressure drop was noted up to a 12-hour shake interval.

Statistical evaluation of the first test series data indicated interactions between the baghouse parameters. The fiber emissions were reduced at longer shake intervals. The major conclusion reached regarding asbestos emission control was that fiber emissions were minimized by the least frequent disturbance of the bags.

The Project Report was submitted in fulfillment of Contract No. 68-03-2558 by IIT Research Institute under the sponsorship of the U.S. Environmental Protection Agency. The report covers the period from June 27, 1977 to September 30, 1979.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Cincinnati, Ohio, 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).

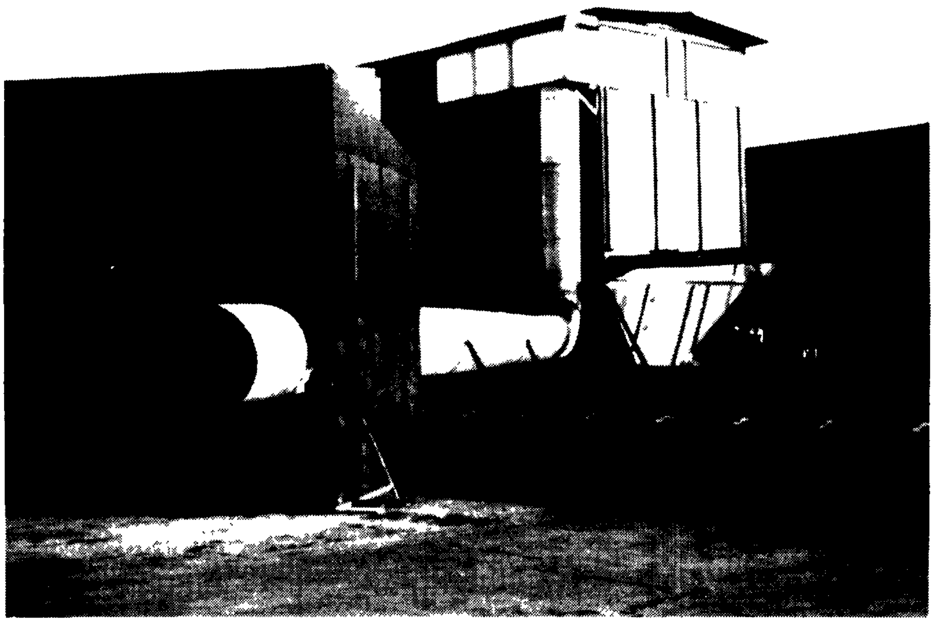

Figure 1. *Baghouse for asbestos removal, showing plenem, ducting and effluent sampling station.*

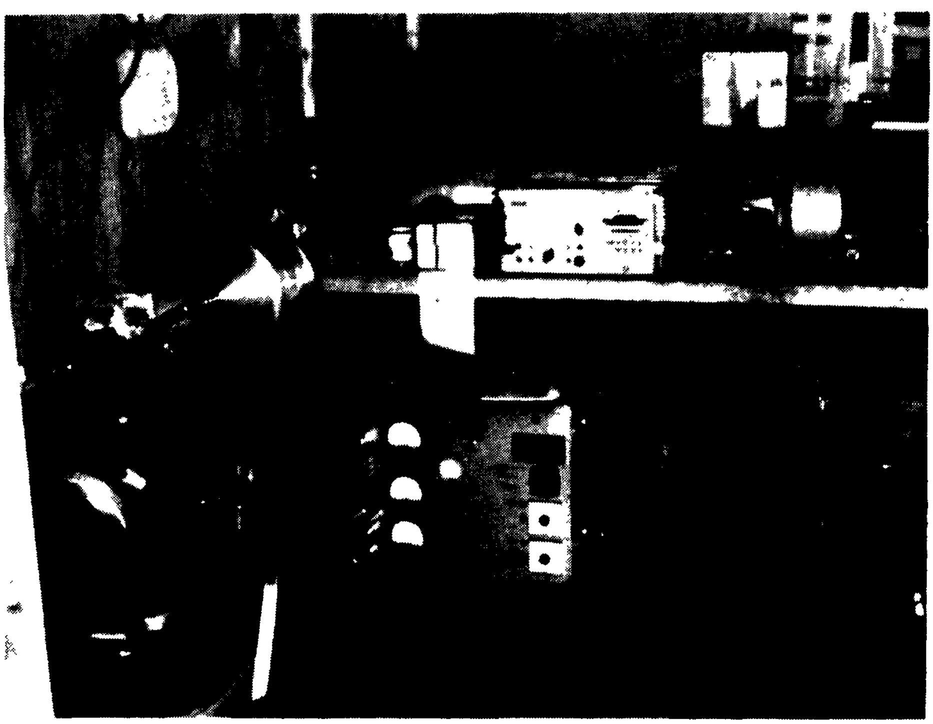

Figure 2. *HVSS sample train and effluent monitor.*

Introduction

Processes involving asbestiform minerals are known to produce significant quantities of waste materials which release airborne asbestos fibers. Airborne asbestos fibers have been associated with asbestosis and other respiratory diseases. The prevalent control device used to minimize the emission of airborne asbestos fibers to the environment is a fabric filter used in a form known as a baghouse.

This report describes a field research program whose objective was to minimize asbestos fiber emissions. The program demonstrated that, even though a baghouse has an extremely high mass efficiency, literally billions of fibers per hour are emitted from a well-controlled source.

While current asbestos data do not permit the determination of the health effects, it is prudent to maximize the control of asbestos emissions using the most feasible, economical and effective methods available.

Asbestos fibers are implicated in the development of diseases with 20-40 year latency periods, and to date no threshold exposure value has as yet been defined. It is possible that even very small asbestos fiber emissions could have a long-term impact on the national health.

Previous studies had shown that fabric filters were the most common and effective method of controlling emissions from asbestos processes. Variations in the operating baghouse parameters were believed to affect the degree of control achieved. In this study, a full-scale commercial baghouse was operated at specified conditions, and its degree of control measured by monitoring emission fiber counts.

The objective of the study was to identify the significant operating parameters, and to determine what conditions provide maximum control of asbestos fiber emissions. The fiber count method was used, since the variations on a mass basis are too small to measure.

This research study has origins in past projects done at IITRI and in EPA's continued interest in the improvement of control technology for asbestos fiber emissions from industrial sources. The initial effort was a two-phase program performed under EPA Contract No. 68-03-1353. Phase I results are reported in EPA-650/2-74-088 and Phase II results in EPA-600/2-76-065.

Statistical Evaluation of Baghouse Test Data

The primary objective of the fractional factorial statistical evaluation was to define guidelines for the optimum operation of baghouses for control of asbestos emissions. This was done on a full scale baghouse in use on an actual operation generating asbestos emissions. The parameters selected for investigation were:

- the period of time between shake cycles,
- the duration of the shake cycle, and
- the shake amplitude.

During the first series of tests on the program a data base was assembled permitting statistical analysis of the three baghouse parameters, monitoring of the baghouse condition, baghouse inlet loading, and data permitting a check on the validity of the samples.

All of the data were associated with 93 individual samples taken during the test program. The specific data base used in the statistical analysis consisted of fiber concentration in number of fibers/SCM. The data were obtained using electron microscopy (EM) on each of the 93 samples obtained. Additionally, each of the inlet loading values obtained from all but combination 2 was also entered into the analysis as a possible co-variate variable.

Prior to the linear regression analysis of the design, statistics on each of the combinations were obtained. These statistics were used to verify the homogeneity of the fiber counting data and various transforms. The variance of the fiber count data varied widely from combination to combination ($P>.001$). The variance of the square root transform also fluctuated ($0.10 > P > 0.05$), while the log transform was more stable ($0.3 > P > 0.2$). On the basis of Bartlett's test, the log transform was considered suitable for use in obtaining a pooled estimate of the standard deviation. The estimated pooled standard deviation obtained on the basis of 81 degrees of freedom was $s = 0.49$.

The summary of major conclusions based on linear regression analysis of the primary data base were:

- Two of the selected parameters, shake duration and shake amplitude, showed the maximums in their output curves. The existence of a maximum rather than a minimum implies either that there is no optimum, or that the optimum is outside the experimental range of the parameters.
- The shake period showed a minimum at the midpoint of the values studied.
- A positive correlation between mass loading of the baghouse and the output concentration has been obtained.
- The lowest output concentration obtained is equivalent to the baseline concentration. The baseline conditions are outside the range of parameters studied.
- All values of concentration measured were at approximately 10×10^6 to 50×10^6 fibers/SCM. This is equivalent to 10-50 fibers/cc in the baghouse outlet. Also, since about 10 percent of the total fibers are above 5 μm in length, the OSHA concentrations measured in the baghouse plenum would be 1-5 fibers/cc.

There were two conclusions which required additional study. The first was that a previous study had showed, by similar statistical analysis, that the type of waste was more significant than the mass loading. The second was that the baseline data, obtained at a 12-hour shake period and 300-sec shake duration, showed an output concentration equivalent to the lowest obtained in the experimental design. The shake period and shake duration were greater than those studies, while the shake amplitude was identical to the longest amplitude used in the design.

From the data taken, the conclusions are:

- Extending the length of the period between shakes is beneficial.
- For some applications, the pressure drop is not significantly affected by extended shake interval.
- Automation of the shake cycle leads to better performance of the baghouse.
- Shake duration at extended intervals between shakes is not a significant parameter.
- The duration of the shake cycle seems to be the most important parameter, both from statistical and observed standpoints.
- Interactions between variables are important, but cannot be computed from the partial factorial experiment. The interactions make formulation of a design equation impractical.

Conclusions

The single most important variable in the level of asbestos fiber emissions from a baghouse is the duration of the shake time for the bags during the cleaning operation. The next variable in importance is the amplitude of the shake, followed by the shake period. These three variables account for about 40% of the output variability from a baghouse.

The interactions between the three design parameters of shake period, shake amplitude and shake duration are important in operating a baghouse. The measured asbestos fiber emission rate from a baghouse is dependent on the material being processed and the process rate.

The lowest values of baghouse output measured were 6 million fibers/m^3 and the highest 32 million. The lowest value showed fiber concentration of 0.3 fibers/cc $>5\ \mu m$ (300,000 fibers/$m^3 >$ $5 \mu m$) on the average. However, one sample included in this average approximated the OSHA limit of 2 fibers/cc (2 million fibers/$m^3 > 5 \mu m$) of air. Fiber counts exceeding the current OSHA limit of 2 fibers/cc of air $> 5 \mu m$ in length were numerous.

The lowest concentrations of fibers emitted were achieved when the baghouse was operating at conditions which favored greater cake build-up on the bags. The combination was: short shake/small shake amplitude and long shake period. No detrimental effect on pressure drop was noted at the most efficient conditions. In fact, no correlation of performance with pressure drop was found. The baghouse, even though it has an extremely high mass efficiency, does emit literally billions of fibers per hour under optimum conditions.

Recommendations

The baghouse exit air fiber levels must be reduced below 100,000 fibers $> 5 \mu m$ per cubic meter to be considered for recycle. In lieu of current optimum conditions as defined by this research, the baghouse alone cannot produce the levels of control required. Additional research is necessary to assess what if any control technology is capable of producing an emission of less than 100,000 fibers $>5 \mu m$ per cubic meter.

The use of statistical design techniques when evaluating or optimizing control device performance is recommended. Statistical designs for continuous data are quite efficient to use and provide cost effective programs. The data obtained on a statistically designed program will provide, at a minimum, guidance for future work and trends; at its best, when all assumptions are correct, the maximum information is extracted from the data.

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***Mary K. Stinson** is the EPA Project Officer (see below).*
The complete report, entitled "Characterizing Baghouse Performance to Control Asbestos Manufacturing Source Emissions," (Order No. PB 81-231 250; Cost: $8.00, 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 Officer can be contacted at:
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