

OVERVIEW OF PRESENT STATUS OF CONTROL HARDWARE AND EMISSION COMPLIANCE

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Introduction

It has generally been held that three basic types of air pollution control equipment are capable of meeting the Federal new source emission standards for particulates from municipal sized incinerators promulgated in December of 1971 - electrostatic precipitators, fabric filters, and high-energy scrubbers. In a recent study for EPA, a major U.S. research laboratory indicated that this same overall control technology was capable of meeting proposed stringent new standards for fine particulates. Currently there is work underway in this country on heavy metal and PCB emissions, W. Germany and Ontario have regulations on emissions of chlorine, a number of states have regulations on carbon monoxide emissions, etc. Thus, over the next several years, more and more attention will focus on control of fine particulates and gaseous emissions from stationary sources such as incinerators.

Unfortunately, in spite of indications from published data and EPA studies that control technology was readily available to meet their new standards, field tests of full-size installations have not always confirmed their assumptions. Further, we still do not, today, in 1976, five years after promulgation of the EPA method of test for particulates (Method 5), have general agreement on what constitutes a proper method of test. Local jurisdictions are using their own methods for enforcement of particulate emission limitations. Usually little or no information is maintained on furnace operating conditions during the emission test, and the number generated by the test is usually treated as an absolute indicator of extreme precision for plant emissions. In other words, there are problems. I will attempt to give a brief overview of the general state of technology in emission control and testing at incinerator installations.

Electrostatic Precipitators

Of the three control techniques indicated as having application in this field, the electrostatic precipitators have given the most consistently successful results with respect to particulate emission test results. Most of the approximately 3 dozen units that have been installed at plants on this continent since the early 1970's have successfully passed their acceptance tests. Many of these plants have achieved emission test results well below the Federal new source emission standards.

I would issue several cautions. Approximately one-half of the plants that have successfully passed emission tests have been installations in which the gases were cooled by boilers (the only moisture in the gases was from the refuse and the combustion process), and in most cases the basis of assessing emission control performance was measurement of dry, filterable particles. One plant at which the impinger catch was included in assessing emission compliance, and where the furnace gases were cooled by water sprays prior to passing through the precipitator, had not passed the Federal standard in six tests for which I have results. To the best of my knowledge it has not achieved that magic number, based on total catch, to date. Further, at this plant and another with an electrostatic precipitator, where measurements were made of the impinger catch, the dry filterable material ranged from 14% to 80% of the combined dry + impinger catch. Because of this large, generally unpredictable, variation in impinger catch, to my knowledge none of the major electrostatic precipitator manufacturers will guarantee compliance today with a code which requires a method of test including the impinger catch.

Fabric Filters

Experience to date with fabric filters in this service is very limited. The U.S. plant referred to in the Federal 1971 support document for their new source emission standards, operated briefly early in the 1960's. Emissions were cited as being on the order of $.046 \text{ g/m}^3$ (0.02 gr/SCF) at 12% CO_2 . However, no information was given as to the basis of test. I would have to assume, based on the date of this installation, that only dry filterable material was considered. Also, depending on the test method, the test filtration device might not have been as efficient as modern test equipment.

Another fabric filter, on a demonstration plant near Buffalo, N.Y., burned out relatively early in the plant operation. I have never heard of emission tests on this plant and so assume that the baghouse was rendered inoperative before stack tests were conducted. A pilot operation has also recently been conducted at the Nashville, Tenn., plant. Since inconclusive data was available from the tests at the time a decision had to be made regarding what type of equipment to utilize to meet a compliance order, it was decided to install an electrostatic precipitator. A cyclone-fabric filter apparently has been operating successfully on CEA's E. Bridgewater, Mass., plant for some time. I have recently seen a tabulation of test results on this installation which indicate extremely low emissions. However, in order to properly evaluate any installation today, it is necessary that one have complete, detailed information on the tests conducted along with information on incinerator operation during the test.

High - Energy Scrubbers

The third control technology that has been cited as being capable

of meeting current and proposed new particulate emission standards for incinerators is high-energy scrubbers. I can best sum up the experience to date with the actual application of this technology to this emission source as - the promise and expectations have not been fulfilled by the test results.

To my knowledge, some 19 so-called "tray-type" units and 14 venturi scrubber units have been installed on municipal sized incinerator units since the mid to late 1960's. The tray-type units, medium-energy scrubbers, are generally conceded to be incapable of meeting the Federal new source emission standards. However, they were thought to be capable of meeting some of the state codes for older incineration units. Venturi, or high-energy scrubbers have been used more recently when the installation was required to meet the Federal emission standard or some comparable or more stringent State standard. Test results on these installations have generally been higher than anticipated and, perhaps even more disturbing, have usually been more variable than results on other types of control equipment.

The generally unsatisfactory emission test results on plants utilizing this type of control equipment has led to implementation of several independent, fairly extensive testing programs attempting to pinpoint the problem area or areas. An effort has also been initiated to attempt to bring the information together from these independent investigations in an ASME Research Subcommittee. Results to date have been inconclusive. However, several observations can be made by way of summarizing the present state of knowledge in this field.

Based on published, and other available information on particle size distribution curves and fractional collection efficiencies of venturi scrubbers, a throat pressure drop in the range of 3.74 to 4.98 KPa (15 to 20 inches W.C.) should be adequate to meet the Federal new source emission standard. This is also the conclusion of several recently published EPA studies. The particle size distribution curves, and the conclusions with respect to required pressure drop, are not specific for a certain type of incinerator, an incinerator burning a certain type of waste, or an incinerator operated more or less carefully than other incinerators. Emission test results to date on incinerator wet scrubber installations have been extremely variable, as opposed to fairly consistent results on incinerator electrostatic precipitator installations, and do not give assurance of compliance with the Federal standard at the above indicated pressure drop.

In test results available to us, we have seen a minimal apparent return, in terms of increased removals, for significantly greater expenditures of energy in wet scrubbing systems. I have tabulated below ranges in emission test results for four types of wet particle removal systems. The column reported as corrected results includes dry, or "front-half" particles only. In some cases, the tester reported separately both "front-half" and impinger catch. This information was used to establish the range in ratios reported in the last column.

Type Facility	Range in Pressure Drop inches W.C.*	Corrected Emission gr./SCF @ 12% CO ₂ *	Ratio: Front Half Total
Water Sprays	less than 1/4	0.19 to 0.72	24%
Wetted Baffle Walls	1/4 to 4	0.10 to 0.9	8 to 85%
Tray Scrubbers	3 to 11	0.025 to 0.6	55 to 87%
Venturi Scrubbers	8 to 20	0.01 to 0.61	50 to 92%

* Conversion factors: 1 (in W.C.) = .249 (k Pa)
1 (gr./SCF) = 2.3 (gr/m³)

It is interesting to note in the above tabulation that the range in reported results for tray and venturi scrubbers are very similar, and these results are not too much better than the results for wetted baffle walls. Also, in all tests on tray and venturi scrubbers over half the total catch (where this information was available) was retained in the front half of the test train, whereas in the tests on the wetted baffle walls the front-half catch varied from 8 to 85% of the total catch.

Unfortunately, in spite of the many tests that have been conducted over the past 4 to 5 years on plants utilizing wet scrubbing systems for emission control, there is insufficient cohesive technical data which can be correlated to provide an explanation of the poor emission test results. Thus, most of the tests contain no discussion of the incineration equipment, the refuse composition, and the incinerator plant operation (temperatures, combustion air flow, etc.) during the test. Few test reports comment on furnace charging rates during the tests, and it is very unusual to see a description of how the furnace charging rate was determined during the test. I have never seen a report indicate that the physical condition and operation of the scrubbing equipment was rigorously inspected immediately prior to the test. One assumes that the manufacturer would do this as a matter of course to protect his interest in the facility.

A number of people feel that the secret of the poor test results is a chemical phenomenon occurring either before, in, or following the wet scrubber. To prove or disprove these theories, there should be fairly rigorous data on the chemical characterization of the total (solid, liquid, and gaseous) effluent flue gases. This data does not exist and is quite expensive to obtain. The possibility of water carry-over from the scrubber-separator has been checked at one plant by adding a tracer chemical to the scrubber recycle water, and then checking for this chemical at the stack test ports. Little of the tracer chemical was found, although, at the same time, a substantial flow of water droplets was observed passing an observation port just upstream of the ID fan which was on the wet side of the scrubber. Some physical and chemical characterization work has been done on material caught at the stack sampling ports but, in the absence of information on the physical and chemical makeup of the influent gases to the scrubber, it is difficult to draw definitive conclusions.

Another variable in the interpretation of test results is the testing methods themselves. It is, or should be, well known by now that emission test results can differ widely depending on the method of test utilized, differences in sampling crew techniques, and the effect of sampling conditions. Many of the earlier tests simply reported that the "ASME test method" was utilized. This method, of course, does not stipulate that a specific filter must be utilized (filter must be at least 99% efficient in collecting dust over 1 micron in size). I have seen test results where the dry filter catch was doubled when a fine porosity, rather than a medium porosity, thimble was utilized. Most test reports don't include information on the grade of thimble or filter porosity. While the variability of test results due to variations in details of the test train components, crew training, techniques, and experience, and sampling conditions are of concern, of even greater concern is the use of test trains by some state and local regulatory agencies that are substantially different than the EPA Method 5 or the in-stack thimble method. The thrust of most of these changes in test methodology is to include material trapped in impinger bottles in the total reported particulate catch. This adds a totally unknown quantity to an already perplexing technical puzzle. Collaborative testing by both EPA and ASTM, which was completed within the past year, indicated that impinger catches are subject to variations in results as great as 20 to 1 on highly controlled sources to 5 to 1 on poorly controlled sources. In view of the many other sources of variation in emission test results in this type of facility, it seems to be entirely inappropriate to use a test methodology that, in and of itself, is subject to such extreme variations in results.

Summary

Of the three basic types of air pollution control methodology that has been generally considered to be capable of meeting current air pollution control regulations, the overall experience to date may be summarized as follows:

electrostatic precipitators - generally satisfactory; fabric filters - too limited to reach a definitive conclusion; and wet scrubbers - generally unsatisfactory. In attempting to pinpoint the reasons for the generally unsatisfactory wet scrubber emission test results, a number of deficiencies in presently available data have been identified. Thus, there is usually little data available with which to interpret test results in light of variations in furnace combustion systems, variations in material being burned, and variations in furnace operation during tests. There is little or no information on the effect of scrubber design details and operation on test results. There is limited, widely dispersed, and largely uncoordinated information available on the chemical composition, and size and shape of particles, carried in the flue gas stream and caught in the test trains on these installations. Some limited testing has been conducted to determine the impact of water carryover on high particulate emissions. Test reports, also, generally have not included enough information to properly evaluate the effect

on reported emissions of location and number of test points used, Orsat data generation and interpretation, effect of different sampling methods and techniques, and the method of calculating and expressing test results.

In order to develop a technically sound explanation for the current generally unsatisfactory test results at incinerator wet scrubber installations, an extensive, rigorous testing program should be developed for implementation at one, or several, of the existing installations. Wet scrubbing systems have potential application at these installations in the future for control of fine particulates and/or gaseous emissions. Whether or not this technology is truly available for application in the future in this field is dependent on development of adequate, definitive data on which to base a rational design. Such data is not presently available and can only be developed through the above indicated extensive, rigorous testing program.