Incinerator Testing Programs

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Abstract

This paper is a discussion of the widely varied and uncoordinated efforts to study and evaluate Incinerator design through field and laboratory tests and test programs. The Incinerator industry has not been placed in its proper perspective. Air pollution, fire hazard and combustion efficiency are all elements requiring the specialists in each field to cooperate to produce a Field Standard Acceptance Test and on uniform terms and nomenclature for each assimilation of Laboratory Test data and reports.

The emergence of air pollution problems into widespread public attention has directed attention upon the incineration of refuse in a degree that seems far more intense than the problem really requires — at least in relation to other sources of air pollution. While the Incinerator industry has been steadily working to improve its equipment in all facts of performance, economy and operation, many independent investigators in public and private agencies have embarked upon a program of study — and in some instances research — without a background of experience.

To date, only one Incinerator test program has been carried out by public agencies with the cooperation of the Incinerator industry — the test set up by the American Gas Association, Approval Requirements Committee for Domestic Gas Fired Incinerators! Whatever the reasons for this strange situation, the concern for on-the-site refuse disposal and the growth of the Incinerator industry today really demand a unity of action. This should be a joint effort of the industry as a group, and interested professional people acting as a group in such organizations as The American Society of Mechanical Engineers, the Air Pollution Control Association, and National Fire Prevention Association-National Board of Fire Underwriters. The industry group organization is known as the Incinerator Institute of America, which already has taken the initiative to publish Standards [1] of design and construction, and is ready to join the ASME, the Air Pollution Control Association and the National Fire Prevention Association-National Board of Fire Underwriters in a united effort to modernize our new utility — incineration. The problems of the industry in regard to standardization have been delineated in a paper published about a year ago titled, “What are Standards for the Incinerator Industry” [2].

The economy of refuse disposal evolves upon an economical Incinerator, and manufacturing economy again presupposes standardization. Economy of manufacturing means deletion of nonessentials, use of appropriate materials, employment of mass production methods, and above all, a system of checking by tests in shop and field for quality control. A striking example of American study and standardization is the change in price from an original of $250 for the American Gas Association Smokeless Odorless Incinerators to the $170 on these units after a thorough testing program comprising both laboratory experiments at Battelle Institute and field type tests at American Gas Association’s Cleveland Laboratories.
The next major observation is that each testing program carried out by different individuals and public agencies employed different test procedures and instrumentation. Usually, the findings of one group were not acceptable to another group, with the result that technical information gained has certainly not been used to its best advantage. Obviously, there exists not only a need for standardization in the Incinerator field, but a prerequisite for a uniform test procedure and instrumentation in the nature of the ASME Power Test Code.

The term "incinerator" is defined here to represent not a wire basket, concrete pit, steel drum, etc., but a furnace falling within the Incinerator Institute of America Standards of design and construction. At the same time, a distinction is made between laboratory experiment (which here is considered an examination of combustion characteristics to study effects of variables and to study the various phases of the combustion process) and field test which would be a full-scale test to measure the proficiency of an Incinerator against a standard pattern. There are also tests on Incinerators to check on their performance for the purpose of indicating to the operator the adjustments to be made to maintain efficient performance. These latter tests will be aided by a new direct-reading, particle-counting apparatus under development by Illinois Institute of Technology under sponsorship of the American Public Works Association.

With special reference to Field Tests, a set of objectives must be specified as indicated in Table I which lists several items to be measured. Actually, the emission limitations will not be identical in all areas of the country, but can be set up with some uniformity such as limitation on particulate emission and uniform opacity standard or limits. Where air quality standards so indicate, gas emission limitations may also be set up as an additional control. In all field tests, it is necessary to realize that the users' interests are paramount because they are not only concerned with air pollution (good neighbor policy) but with efficiency as regards rated capacity and use of auxiliary fuel. Also, of concern and of importance to round out a test, are such items as heat transfer, surface temperatures, and distortion of the Incinerator setting under high temperatures.

The problem of creating "typical" test charge and test operating procedures is a very real and important one. It is the author's personal opinion that Type I Waste test as defined in the Incinerator Institute of America Standards will be most nearly typical. As far as operation is concerned, stoking of the charge is not at all typical and operating procedure should be limited to some regulated intervals of charging. As an example of confusion from lack of a standard test, it is interesting to note that two separate tests which were made on the same Incinerator show no apparent relation to each other. Table II shows the data as recorded by each separate laboratory. The differences are not because one laboratory has a better system but that conditions of performing the test varied as to nature of charge, manner of charging, and system or procedure for drawing samples.

**TABLE I**

**INCINERATOR TEST REPORT**

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Particulates Gr./SCF Comb.</th>
<th>Gas Opacity</th>
<th>NOx</th>
<th>Chx</th>
<th>Co</th>
<th>Capacity Lb/Hr. Type Waste</th>
<th>Surface Temp.</th>
<th>Aux. Fuel Btu/Lb Waste</th>
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<tbody>
<tr>
<td>1</td>
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</table>

*Three Separate Points to be Determined*

**TABLE II**

**PERFORMANCE TESTS ON THE SAME MODEL "A" INCINERATOR**

<table>
<thead>
<tr>
<th>Laboratory A</th>
<th>Laboratory B</th>
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<tbody>
<tr>
<td>Gr/cu ft 50 per cent excess</td>
<td>Rev. Const.*</td>
</tr>
<tr>
<td>0.1457</td>
<td>0.0561</td>
</tr>
<tr>
<td>CO per cent</td>
<td>Orig. Const.</td>
</tr>
<tr>
<td>0.20</td>
<td>0.10</td>
</tr>
</tbody>
</table>

**"Revised Construction" consisted of change in angle of auxiliary burner flame, directing it downwards to impinge upon the fuel bed.**
After having watched many field tests and studied many other reports, the author believes that all efforts to concentrate a test period to anything less than three our's duration is not at all realistic. Introducing into the field test any procedures which are not followed in normal operation, such as quenching the fire to end the test, introduces new elements contributing to erratic results and proves nothing.

The Air Pollution Control Association in its TA-3 Incinerator Committee [3] will exert the greatest influence upon sampling procedures and instrumentation concerning air pollution rating, with implementation from Incinerator Institute of America on the development of test charges and firing procedures. Measurement of heat transfer and fire hazard ratings can be incorporated into these same tests. Table 1 shows a suggested Field Test reporting form.

The Field Test, as a yardstick for quality of an Incinerator, may also be used in whole or in part in Laboratory Tests concerned with development in design and materials for improvement of Incinerators although the same need for uniform or standard test procedures is not so necessary here.

The experiments conducted at the Robert Taft Engineering Center by Rose, Stenburg, et al [4], were such that standardization of actual test procedure and instrumentation would not be of considerable importance, since any other reasonable system would not have made any difference on the conclusions reached from analysis of repeated runs under identical conditions. These experiments showed relation of variables in temperature, air supply, air distribution and moisture to various emissions in the gas streams. The charging method used, as well as the fuel charge, while not typical of those encountered in practice, were uniform and served to provide basic conclusions.

It would be at this point that a Field Test might be helpful in confirming the conclusions reached in the Laboratory Test. Incidentally, in the first Taft series published in May, 1958, there seemed to be a reasonable doubt that particulate entrainment resulted primarily from mechanical entrainment by the air traveling through the fuel bed. A later series in June, 1959, confirmed the entrainment to be a function of the velocity of air through the grate or mechanical entrainment rather than a chemical combustion phenomenon. It seems also significant that particulate loading was not a function of the velocity in the secondary chamber.

A similar series of Laboratory Tests [2] was conducted by the author to determine the relation of several designs to each other and to flue-gas emission. These tests were conducted more nearly on actual or typical firing conditions as a Field Test might be run, but a standardized performance test would have yielded even more significant information.

One feature of any test conducted would well be a measurement of the Incinerator performance at its optimum level, at least if a considerable variation exists through adjustment of air supply and distribution, temperatures (secondary burner), and frequency and size of charges. An instance of a confusing report occurs in the recent publication of “Emissions of Polynuclear Hydrocarbons and Other Pollutant from Heat-Generation and Incineration Process” in which two industrial incinerators were compared for their performance in relation of emissions of various gases. The multiple chamber unit, contrary to expectations, does not compare favorably in this test with the single chamber unit. Unfortunately, the tests were not conducted on a uniform basis of refuse composition and charging procedure and comparisons between these two units were difficult to analyze; in fact, it would seem to indicate that something was seriously wrong in the test run on the multiple chamber unit.

Often where comparisons are made, they are not only made under varying conditions but they are reported in different terms that require translation to the same base. Emission in terms of process weight is variously quoted as “Pounds per Ton of Refuse,” “Pounds per 102 of Refuse” and particulate concentration may be quoted in terms of “Lb per 1000 lb flue gas,” “Grain per cubic feet,” “Grain per SCF,” etc. Correction factors for flue gas, temperature, or excess air or CO₂ (excess air again) are also not always shown.

Any test carried out reveals more information on the really complex combustion device that is required for ideal incineration, but the extent of the information depends upon the detail and care with which the report has been prepared.

Our own policy has been to prepare each report in detail containing not only the averages or general conclusions, but the readings and calculations for each sampling, together with calibration of the instruments used.

In conclusion, two procedures are repeated that are urgently needed now, namely:

1) Establishment of a uniform Field Test for an acceptance standard for commercial and industrial incinerators.

2) A more uniform reporting of Laboratory Tests, especially in terminology for particulate loading, gas concentrations, etc.

A direct reading instrument for particulate emissions would be helpful. While a direct reading particulate emission counter would certainly be ideal, the development time in creating a marketable piece of equipment — at least for commercial and industrial incinerators — is not so urgent. On all tests the author has observed, smoke density is a very reliable indicator of particulate loading that may be expected. Heavy visible emission of large particles of fly-ash in a fairly clear exhaust
also indicates fly-ash loadings to an experienced operator.

A conventional smoke density indicator on each installation, plus readily "at hand" controls for the operator (such as secondary burner, air jet, etc.), can really provide excellent operation in any Incinerator conforming to the Standards of the Incinerator Institute of America.

References


