Metal and Particulate Emissions from Incinerators Burning Sewage Sludge and Mixed Refuse

F. L. CROSS, JR.
Roy F. Weston
West Chester, Pennsylvania

R. J. DRAGO
National Air Pollution Control Administration
Research Triangle Park, North Carolina

H. E. FRANCIS
State Department of Health
Hartford, Connecticut

DISCUSSION by E. D. Ermenc, director, Air Pollution Control, City of Cincinnati, Ohio.

While these are interesting data presented, the quantities of metal do not indicate any near future recovery of metals from incinerator stacks which the authors do infer. From a research standpoint approximate values have been determined and this project can be filed for the future.

With regard to these various metals in air pollution, it has been postulated that the various metals will act as catalysts in promoting the formation of smog constituents. More data can eventually be determined with regard to specific reactions but I think it is logical to presume the catalytic effect of these metals.

I believe the article could have had additional value if operating conditions had been spelled out — temperatures, velocities in the combustion chamber, stack, etc. Comparisons could then be made with other installations.

Similarly, I think an attempt to close the metals material balance would have been of interest. Water and gas emission quantities were obtained and possibly an estimate of input would have provided a check.

Of greater present importance would be the determination of the presence of fluorides, chlorides, sulfates, bromides, oxides of nitrogen, etc., in light of increasing use of scrubbers added to incinerator effluent stacks.

DISCUSSION by Richard Goder, Joseph Goder
Incinerators, Elk Grove Village, Ill.

This paper deals with a specialized installation and thus care should be taken to emphasize this point. Also, the date reported are not consistent in that various terms are used that require the reader to make conversions and there are inconsistencies of considerable degree that are not explained.

I make mention of this not as an adverse critical analysis but so that when additional testing is carried out, the reports from future tests will be more lucid. This seems to be the age of half-truths — especially in the area of pollution control.

In Table 1, several discrepancies seem to exist in the dustloading statistics. Concentration is shown in terms of gr/SCF and lb/1000# flue gas. A direct ratio should exist but since this is not the case, some explanation should be made.

Emission Factor does not vary in direct ratio with the concentration. The variation is very great and again no explanation is given to account for this apparent discrepancy.

Both the amount of refuse actually burned plus the changes in gas density from water vapor could possibly account for some of these apparent discrepancies but the explanation is necessary since the data given is not enough to make this determination.

In Table 3, concentration of metal particulates in stack emissions are shown in terms of mg/m³ rather than in gr/SCF used for emission concentration in Table 1. Using the same terms will aid in clearer and quicker study of this paper and determine the relative importance of the data.

Generally, the category (Emission Factor) does not apply very well to combustion processes. Where the economics of recovery are concerned, weight of material recovered in ratio to weight of material burned is important but where pollution is concerned, concentration of dust in the flue gas stream is the important factor with consideration to concentration of total emission for any one area or site.

NOTE: See Errata, page 103.
I believe that the authors have made an important contribution of knowledge for the measurement classification of metallic components from the products of combustion from incinerators. This is one of the most detailed analysis that I have read in regard to incinerator emission.

Before the authors use these data for emission factors or before they become guidelines for the industry, I would like to see more work done in this area. There are several areas where the authors could have strengthened their paper for a better technological presentation.

1. No correlation was made between the metal emissions and the actual metallic composition of the refuse or the sludge. A metallic analysis would have been extremely useful even though it is very time consuming. An analysis of the sludge for metals is rather easy and inexpensive to run and would have added a great deal of information to the paper.

2. More samples are needed to statistically develop emission factors. The small number of samples is conducive to large errors. For example, in Table 2 the clarified overflow has less metals in it when burning sludge and refuse than when burning just refuse. This does not seem to be in line with the trends in the rest of the paper where there are higher emissions when burning sludge. I believe that with more samples and analysis, clarification of this point can be made.

3. The sampling method employed for particulates did not include an analysis of condensibles. I believe that a fairly large portion of some metals are volatilized in the incinerator and exist as a fume or gaseous emission at stack conditions.

To recap the discussion I believe that the authors have shown that a large portion of the particulate emissions from incinerators are metallic. These metallic emissions are of major concern to our public health officials. I believe that additional work must be performed in this area before these emission factors can be used as guidelines.

The authors have added a bit of valuable information to the available literature defining the character and magnitude of the potential air pollution problem from incineration. However, as with much of the available literature, to be of maximum usefulness, it must be properly interpreted and the results used with caution.

Several details regarding Figures 1 and 2 should be clarified. The furnaces at the Waterbury plant are circular, batch fed units rather than continuously fed units as implied in Figure 1. In Figure 2 the gases flow through the checkered baffle wall on which water is continuously applied by the water sprays, rather than down, under the wall and then up as indicated on the sketch. Thus, the gases impinge on a very large wetted refractory surface area in passing through the spray chamber with much of the particulate matter being trapped and carried to the bottom of the chamber by the water.

The State of Connecticut regulations cited in Table 1 are the regulations presently in effect in this State. Approval for construction of the facilities at this plant, which was granted three years earlier, was based on a limiting emission of 0.65 lb dust/1000 lb of flue gas corrected to 50 percent excess air. It will be noted from Table 1 that the measured emission levels were all well below this earlier limit.

The emission factors cited in Table 4 (lb/ton of charge) should be used with a great deal of caution due to the limited accuracy of the measurements of tons of material charged. This weight was determined by counting the buckets of material charged to the furnace during the air pollution tests and multiplying by the yearly average weight of a bucket of refuse adjusted visually for the condition of the refuse at the time of burning (wet or dry). Those familiar with this type of measurement will appreciate the limitations imposed on the accuracy of the results shown.

As indicated by the authors, the factors included in Table 4 should be used as indicators, only, for the following reasons:

1. The sludge burned is a unique sludge from a highly industrialized area with a large portion of the industry being metal industry (copper and others);
2. The limited accuracy of the rate of charging refuse;
3. Comparative data that we have indicates that the particulate catch measured with the test apparatus used in these tests may be only 25 percent of that collected by other types of test apparatus;
4. Other peculiarities of this facility such as: it is a batch fed type of furnace; the air pollution control facilities are a wetted checkered refractory baffle wall; and the furnace draft at the time of the tests was considerably higher than we would normally consider to be desirable.

I believe some of the ranges of stack concentra-
tions and stack emissions of metals cited in the
Conclusions are not in agreement with the data
included in the Tables.

Further, before the recommendations contained in
the last paragraph of the author’s Conclusions can be
implemented, we will need substantially more informa-
tion similar to that developed in this paper but con-
ducted in a more rigorous fashion than was possible
in the case of this study. The authors are to be
congratulated for generating the information that was
contained in this paper over an extremely short period
of time, on short notice, with limited funds and un-
limited cooperation on the part of everyone involved.

DISCUSSION by Gary D. McCutchen, National Air
Pollution Control Administration

I am pleased to see work being done in this some-
what neglected field, but have some reservations
about the accuracy of the emission factors obtained.
The presentation of additional data would have
allowed more of an evaluation of the results.

There is, for example, quite a variation in the
emission factor between consecutive runs. Inclusion
of the burning rate in pounds per hour and combus-
tion chamber temperatures might have helped to explain
the differences in these factors.

In addition, a more detailed description of the
sampling technique should have been included. The
reader is referred to the ASME test code, but no infor-
mation is given on what type of filter is used to collect
the particulate matter and whether or not this filter was
actually 99 percent effective in collecting incinerator
emissions (as the ASME test code requires it to be).

A partial evaluation of the bag’s effectiveness would
also be possible if information on the amount of
particulate collected in the bag versus the tare weight
of the bag were included in the article. This data
can be extremely important, since the manufacturer
of the UOP (Aerotec) Flue Gas Sampler, for instance,
suggests that at least 10 grams of sample material
must be collected in their bag for a valid sample.

The authors state that there definitely were dif-
fferences between the amount of particulate and the
amount of metal contained in the samples depending
on whether refuse alone or a mixture of refuse and
sludge was burned. This conclusion evidently has
been reached without applying any of the statistical
tests commonly used to determine whether two
populations are in fact different. The Mann-Whitney
Two Sample Statistic, for example, indicates that
only the copper, nickel, lead and chromium
populations (d = 0.1, 0.05, 0.1 and 0.05, respectively)
can be considered significantly different.1 Such infor-
mation would have helped in the evaluation of the
data.

One final, minor point: Reference [3] on page 195
appears to be incorrect. I believe that Technical
Committee TA-3 belongs with APCA rather than
NAPCA.

As all too often happens in a discussion, my com-
ments have been almost entirely “negative.” Despite
this, I consider the paper to be an excellent one and
expect that the emission factors developed will
provide extremely useful guidelines for estimating
metallic incinerator emissions.

1Statistical analysis courtesy of William M. Cox, Statistics.
Section, Bureau of Abatement and Control, NAPCA.