Health Aspects of Air Pollution From Incinerators

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Abstract

The public health aspects of incinerator exhaust gases are discussed first in the light of the physiological response induced by specific contaminants such as sulfur oxides, nitrogen oxides, and other inorganic gases and aldehydes, organic acids, esters, polynuclear hydrocarbons, and other organic compounds; second, with respect to their relation to illness caused by air pollution in general such as emphysema and other respiratory diseases, allergenic responses, and cancer; and third on the character of the effluent gases, namely, domestic, municipal, or industrial. One aspect of domestic incinerator effluents is particularly stressed, that is, the effect on nearby residents. The contribution that incinerator exhaust gases make to the air pollution of any given community depends on the ratio of the amount of refuse and garbage burned to the total amount of fuel used and consumed in that region.

Introduction

Residential incinerators serve three principal functions, first, they are a great convenience to the resident for the disposal of his refuse; second, they are of value to the landlord in the reduction of the amount of refuse to be handled; and third, they reduce, as has been pointed out by many, the load and weight of refuse and garbage that have to be carted away by municipal sanitation departments. For instance the garbage and refuse is reduced to about 35 per cent of its original weight and to about 10 per cent of its original volume [1]. The latter is a great economic factor to such municipal agencies. There are approximately 10 to 11 thousand apartment house incinerators in New York City serving some 1.5 to 1.7 million people. It has been estimated that by 1970 there will be 13,000 incinerators serving 2,000,000 persons in New York City [2]. The major source of air pollution from municipal agencies is the operation of refuse disposal facilities.

The severity of any air pollution problem from any given source can be judged in two ways: (1) from the actual contribution that the given source makes to the total amount of air pollutants in a given community and (2) from the number of complaints arising from such a given source. If one were to use the first of these criteria one might conclude that incinerators contribute only a small amount to the overall pollution in the city. It is a fact that the actual contribution of any type of source of pollution to the total pollution of a region is the weight of fuel that is consumed by that type of source. For example, there are some 33-34 million tons of coal equivalent of all types of fuel including coal, fuel oil, gasoline, and refuse, burned in the City of New York and of this total some 600,000 to 700,000 tons are burned in residential incinerators. From the actual contribution point of view, then, residential incinerators comprise only approximately 2 to 3 per cent of the pollutant source. If one were, however, to consider the number of complaints attributable to this source, the...
domestic incinerators comprise 20 to 25 per cent of all complaints. It is clear from the number of complaints that residential incinerator flue gases are a singularly personal problem and have, in many instances, an individual physiological effect.

Some 2 million tons of refuse and garbage are burned in New York City municipal incinerators comprising approximately 8 to 10 per cent of all sources of air pollution in that city. It is to be understood, however, that certain sources contribute far more of any given pollutant than other sources. Thus motor vehicles are the principal source of carbon monoxide and coal burning equipment is the main source of solid pollutants.

You have all heard endless repetition of the Meuse Valley, Donora, Poza Rica, and London air pollution incidents [3]; about the smogs of Los Angeles; the asthma attacks in New Orleans and Yokahama [4]; and even some 9 years later about the excess deaths in New York City in 1953 [5] (the author pointed out these excess deaths in a paper prepared for publication in 1954, and published in 1962 following a number of revisions).

Extensive research, both laboratory and clinical, has shown that there is a distinct relationship between air pollution and health. In a recent report [6] prepared for the Special Subcommittee on Air and Water Pollution of the Senate Committee on Public Works it is stated that there is strong evidence that air pollution is connected with a number of respiratory illnesses. Among these are: 1) nonspecific infectious upper respiratory disease, 2) chronic bronchitis, 3) chronic constrictive ventilatory disease, 4) pulmonary emphysema, 5) bronchial asthma, and 6) lung cancer. Such ailments are due to or are affected by the contaminants that comprise air pollution. What are these contaminants?

From the very beginning of the Bureau of Laboratory of the New York City Department of Air Pollution Control, in 1953 under a directive of the Air Pollution Control Commissioner, Braverman and Hochheiser and the author, subsequently joined by Theophil and Ettinger (this was almost two years before the Federal Government started work in the field) devised a series of methods for the determination of the pollutants emitted by incinerators [7]. In 1957 the Bureau of Laboratory was joined by a group from the New York University College of Engineering headed by Kaiser [1] for a collaborative study of the performance of flue-fed incinerators. The New York University part was supported by a research grant from the National Institutes of Health, Public Health Service, U.S. Department of Health, Education, and Welfare.

The effluent from an incinerator contains materials which can be placed into 3 categories: 1) inorganic gases, 2) organic substances, and 3) particulate matter. In the first category are sulfur dioxide and sul-

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<td>Range of Concentrations of Incinerator Flue-Gas Components [7]</td>
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<tr>
<td><strong>Compound</strong></td>
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<td>Oxidizable Sulfur Compounds</td>
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<td>Nitrogen Dioxide</td>
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<td>Ammonia</td>
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<td>Carbon Monoxide</td>
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<tr>
<td>Carbon Dioxide</td>
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<tr>
<td>Oxygen</td>
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<td>Particulate Matter</td>
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*Furnace gas corrected to 12 per cent CO₂.*

**Physiological Effects of Incinerator Effluents**

It would not be feasible in the short time available to me to discuss the physiological effects of all the incinerator effluents in great detail but brief comments can be made using the chemical classification given in the preceding section. Most of these have been abstracted from my book on industrial poisons [8].

**Inorganic Gaseous Effluents.** 1) **Sulfur dioxide** is an irritant gas that is practically irreparable. It affects the upper respiratory tract but with deeper breathing affects the lower tract also. Apparently inert particles increase the irritant action [9] of this gas. Our work showed little sulfur dioxide to be elaborated.

2) **Sulfur trioxide** and **sulfuric acid** are inhaled as droplets or form droplets and attack the upper respiratory tract. Some people are extremely sensitive to sulfur trioxide and sulfuric acid. It is unlikely that sufficient SO₃ is in the incinerator gas effluent to have a corrosive acid effect.

3) **Nitrogen oxides** in incinerator flue gas consist principally of nitrogen dioxide-nitrogen tetroxide and nitric oxide. The nitrogen oxides are insidious poisons for they have no immediate pronounced physiological effect and may be deeply inhaled.

4) **Ammonia** is another gas that affects the upper respiratory tract. There has been recent work that has
indicted ammonium sulfate [10] as one of the principal factors in illnesses caused during high pollution incidents.

5) Carbon monoxide, a colorless and odorless gas, is a chemical asphyxiant which produces its harmful effect by combining with the hemoglobin of the red cells, thus preventing these from delivering oxygen to the body tissues. Recent work seems to indicate that continuing exposure to relatively low concentrations of carbon monoxide may cause harmful effects [11].

6) Carbon dioxide, a colorless, odorless, and slightly acid gas, is a relatively innocuous substance in low concentrations, that is, in concentrations below 0.5 per cent but it can be a serious poison in higher concentrations and has been the cause of accidents and deaths.

Organic Effluents. There are a great many organic compounds in the effluent gas from incinerators. Indeed, no very good study of such compounds has yet been made. Consequently one can only consider such compounds according to functional groupings.

1) Aldehydes. The principal aldehydes in incinerator effluent are probably formaldehyde and acrolein. Formaldehyde has a pungent odor and a suffocating effect. It has an irritating effect on the eyes, mucous membranes, and the skin. Acrolein is intensely irritating to the eyes and respiratory tract and was used as a lachrymator poison gas during World War I. It is to be noted that acrolein can readily be formed by heating fats and oils.

2) Organic Acids and Esters. In the breakdown of foods, particularly the fats and oils in foods, organic acids and esters are liberated. These, except in special cases, are not considered to be dangerous compounds.

3) Phenols. In the decomposition of foods and refuse during improper combustion, phenols and phenolic substances are liberated. Some of these do have harmful properties but their effect as incinerator effluents has not been fully investigated. They are present in relatively low concentration.

4) Polynuclear Hydrocarbons. Intensive investigation of the amount of polynuclear hydrocarbons, also called polycyclic hydrocarbons, as components of the total air pollution complex has been carried out in a number of countries. These are formed by synthesis in the combustion processes in the incinerator and may also be liberated from certain of the materials by the heat of the incineration. Some of these substances are known to be carcinogens.

Particulate Matter. The smoke, soot, fly ash, grit, etc. consist of particles of all different sizes. Some of these have a physiological effect, not only because of their chemical character but also because of their size. Some of the particles are impregnated with the acid gases mentioned above and may be breathed into the lower respiratory tract in this way.

Personal Health Problem

The incinerator, particularly the residential incinerator, often presents an individual with a personal health problem in contrast to the health effects affecting all of us from general air pollution. Such personal health problems arise not only from the inhalation of incinerator effluent gas and its loading from an externally located, nearby incinerator but also often from the incinerator in the house of a resident, for not only do downdrafts carry incinerator effluents into the home of a resident but in addition, improper functioning of the incinerator produces smokeouts and gassing, filling the entire apartment house with unpleasant odors and noxious gases [12].

As part of this personal health problem, many a resident may be allergic to some of the components of incinerator effluent and be seriously affected by such emissions. In some respects the nuisance and hazards from incinerator gases produce an emotional response in some people. This is also a health problem.

General Health Problem

There is one other aspect of the incinerator problem that is peculiar to Manhattan and should be mentioned. In central Manhattan many buildings do not have their own heating equipment and obtain steam for this purpose from a central source. In this area, then, since very little fuel is consumed for heating purposes, a major source of local air pollution is incinerator effluent. This, of course, is not the only source, for motor vehicles are also a very important source of pollution, but incinerator effluents loom relatively larger in importance where steam is obtained from a major central source like a steam corporation. It may also be inferred in such instances that the effect on health from local sources of air pollution may be more important than generally considered.

When people live in urban areas they have certain marked conveniences but along with these conveniences, there are also certain hazards to which they are exposed. We know that over fifty years ago there was relatively little lung cancer. Today lung cancer kills many people, approximately 40,000 in the United States in 1960, more in urban than in rural areas. Very likely air pollution is a contributing factor. In the United States the incidence of diseases such as chronic bronchitis and emphysema are being diagnosed with greater frequency. This is due not only to better methods of recognizing such diseases but is also due to an actual increase in such illnesses. Here too, air
pollution is a contributing factor. Since incinerator flue gases contain many of the pollutants common to general air contamination, and in relatively high concentrations as one can see from Table I, one must conclude that such effluents also are a contributing cause of such illnesses.

Some work has been done on estimating the contribution of incinerators to the general air pollution problem [1], [2], [12], but virtually no work has been done with reference to the role that incinerators play on the health of a community. For this reason it has been necessary to discuss these effects only in general terms. The amount of pollutants given off by both domestic and municipal incinerators is sufficiently large to warrant a complete study of the effects on health caused by these emissions.

Summary

The refuse and garbage burned in domestic, that is, residential incinerators comprises only 2 to 3 per cent of all the fuel consumed in the City of New York. Nevertheless, it is clear from the number of complaints that incinerator flue gases affect many people. Municipal incineration comprises about 8 to 10 per cent of the total fuel burned in New York City.

Incinerator exhaust gases contain substances that are known 1) to have an effect on the respiratory system, 2) to induce allergenic responses, and 3) to be implicated in causing cancer. Incinerator flue gases not only add to the general air pollution problem but have a singularly personal effect on residents. This may be increased by an effect known as smokeout or gassing which, since it occurs indoors, may not be considered by some as air pollution. The public health aspects of flue gases from incinerators have not been fully investigated. This problem requires further and intensive study.

References