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# MICROBIOLOGICAL STUDIES OF COMPOST PLANT DUST

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National Environmental Research Center
Office of Research and Monitoring
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Cincinnati, Ohio 45268

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# MICROBIOLOGICAL STUDIES OF COMPOST PLANT DUST


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## FOREWORD

Man and his environment must be protected from the adverse effects of pesticides, radiation, noise and other forms of pollution, and the unwise management of solid waste. Efforts to protect the environment require a focus that recognizes the interplay between the components of our physical environment—air, water, and land. The multidisciplinary programs of the National Environmental Research Centers provide this focus as they engage in studies of the effects of environmental contaminants on man and the biosphere and in a search for ways to prevent contamination and recycle valuable resources.

The study described here was made to determine the nature and extent of respirable microorganisms emitted into the atmosphere during the storage, processing, and composting of municipal solid waste and sewage sludge. The results of the study will serve as basis for developing guidelines for environmental air concentrations related to solid waste handling operations.

Andrew W. Breidenbach, Ph.D.
Director, National Environmental
Research Center, Cincinnati

## TABLE OF CONTENTS



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# ABSTRACT

To help evaluate the effects of solid wastes handling and processing on the microbial quality of the environment, a quantitative study was made of the microbial flora of the dust in and around a municipal solid waste-sewage sludge composting plant. Air samples were taken with an Andersen volumetric sampler used in conjunction with trypticase soy agar that contained 5% sheep blood and with eosin methylene blue agar. Sampling was carried out during the inactive and active work periods. Samples were obtained from ten different areas at a height of 5 ft. The highest total microbial counts of 63 and 55 per 0.25 cu ft of air were obtained in the leveling and metering gate area of the receiving building and in the rejects hopper area of the processing building. *Staphylococcus aureus*, gram-negative bacilli, gram-positive bacilli, and fungi were present in all areas sampled. No coliform organisms were among gram-negative bacilli.

## INTRODUCTION

The effects of airborne microorganisms in a number of human environments have been reported by Robertson, 1967; Greene et al., 1962; Winslow, 1926; Williams et al., 1956; and Cvjetanovic, 1958. A study of airborne microorganisms inside municipal incinerators (Peterson, 1971) has shown the potential health hazard of dust from municipal solid waste. Other research in this field has included a study of airborne microorganisms around a sewage treatment plant (Kenline, 1967); the study indicated that streptococci may spread several hundred yards from the source.

This study of dustborne microorganisms was carried out at the Joint U.S. Public Health Service - Tennessee Valley Authority Composting Project, Johnson City, Tennessee, where the windrow system was used. The compost was made from ground municipal solid waste mixed with raw or partially digested sewage sludge. As with any solid waste handling and processing operation, the composting process can concentrate and stir up dust that may be a health hazard to the persons who come in contact with the dust. In this case, there is threat of contamination from both the waste and the sewage sludge.

## MATERIALS AND METHODS

Air sampling equipment and techniques. Air samples were taken with an Andersen sieve sampler (Andersen, 1958), (Figure 1). This six-stage multijet sampler separates airborne particles into six aerodynamic sizes that cover the range for respiratory tract penetration. Thus, the organisms reported in the data are primarily those that could enter the respiratory tract. Each of the six stages of the sampler covered a petri dish containing 26 to 28 ml of solid agar media. Air was drawn through the sterile sampler at 1.0 cu ft per min with a vacuum of 15 in of mercury. Because of the large numbers of organisms involved, the sampler was run for 15 sec (0.25 cu ft air) to get well separated 1 to 30 colonies.

Background samples were taken at times of complete inactivity after the dust had had at least 24 hrs to settle. Activity samples were taken at times when the dust reached its maximum levels.

Media. At each sampling site, the sampler was used with two types of media: tryticase soy agar (TSA, BBL product) that contained 5% sheep blood and eosin methylene blue agar (EMB, Difco product). The TSA/blood agar was used to isolate a wider range of fastidious organisms such as staphylococci,

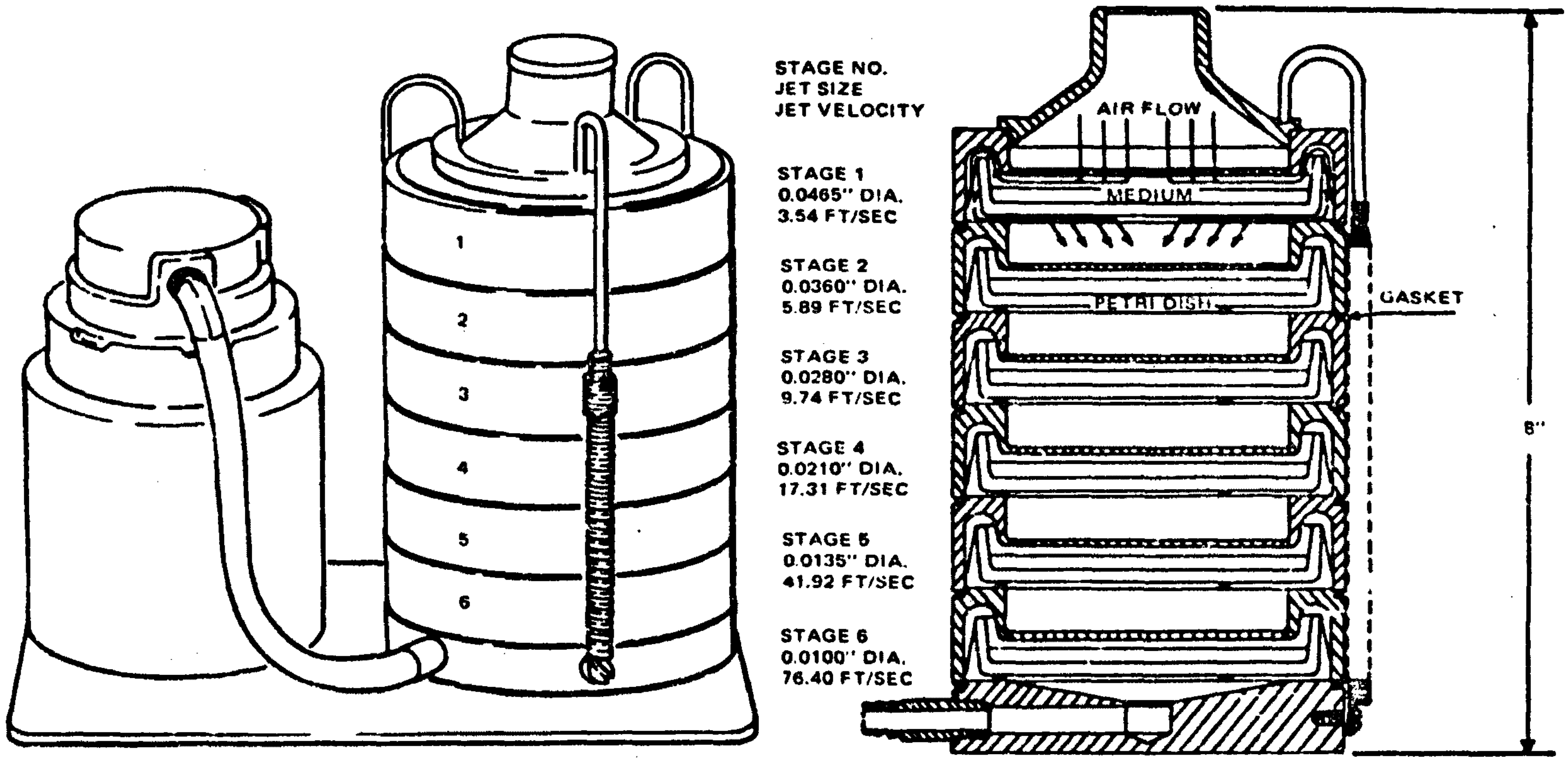


FIG. 1. ANDERSEN SIEVE SAMPLER

streptococci, and pneumococci. The EMB agar was used to isolate gram-negative bacilli. The plates were incubated aerobically at 35 C for 24 hrs. (Preliminary studies showed that only a few organisms in the dust would grow under anaerobic conditions). A Quebec colony counter was used to enumerate the colonies. Representative plates were retained for further characterization of microorganisms.

Sampling locations. Samples were taken at 5-ft heights from 10 selected sites throughout the composting process area where dust might be produced (Figure 2):

- the receiving hopper area where solid waste is dumped onto the conveyer (1);
- the leveling and metering gate area where a man works in a confined area guiding the waste through the gate (3);
- the hand picking station where waste is separated by two men (6);
- the rejects hopper area where the rejected material is dumped into a truck (5);
- the grinder throwback area where dust is produced from the grinding operation(8);
- the premixer area where sewage sludge falls down a chute and is mixed with the ground waste (9);
- the postmixer area where the mixed sludge and waste are

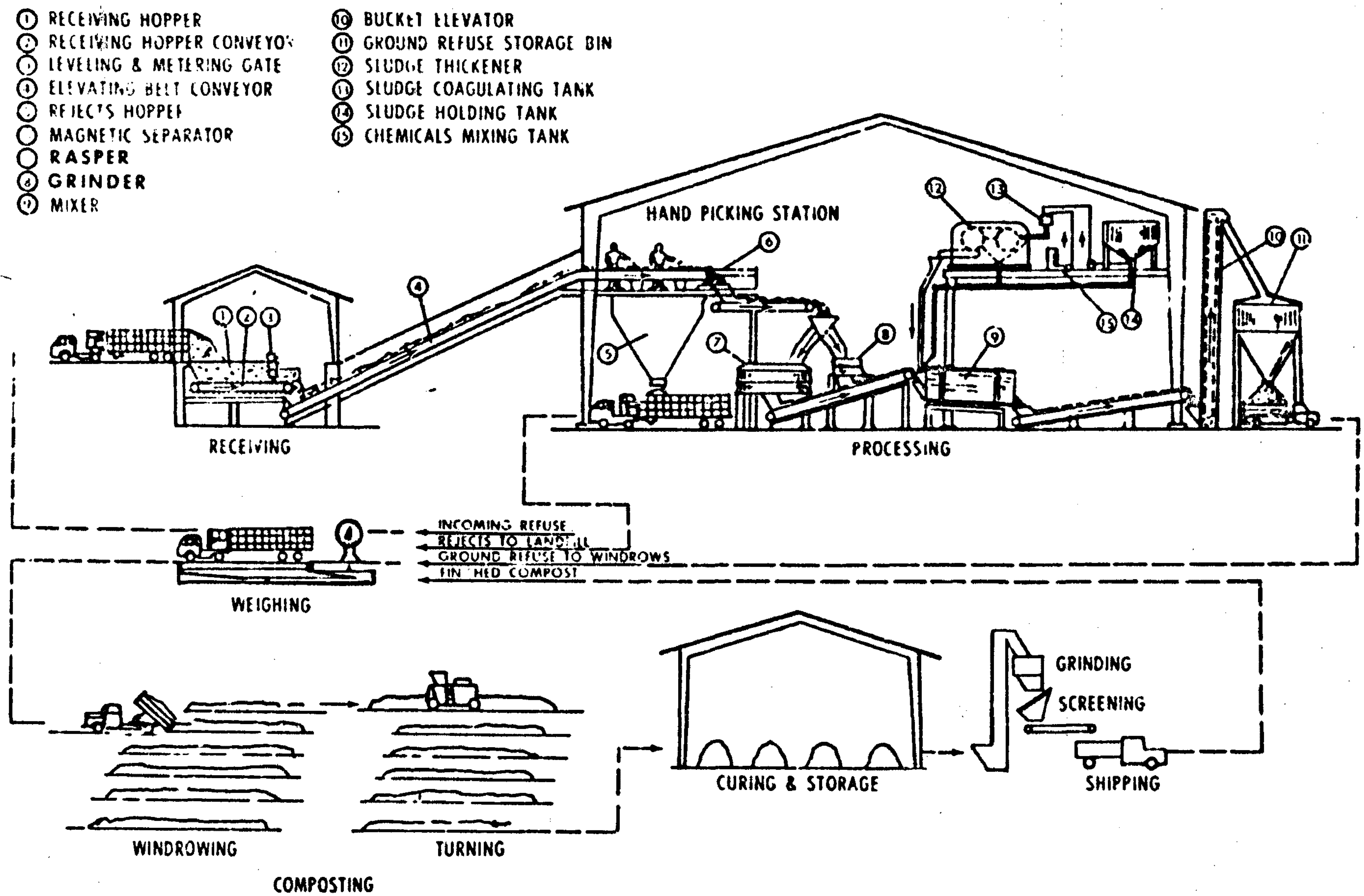


FIG. 2. PROCESS FLOW DIAGRAM OF USPHS-TVA COMPOSTING PROJECT, JOHNSON CITY, TENNESSEE.

transferred to a belt (9);

- the ground-waste transfer area where the waste sludge mixture is dumped into a truck (11);
- the windrow area where a 7-day-old windrow is being turned over (downwind); and
- the curing and storage area where the cured compost is being transferred to a truck (downwind).

The air temperatures during the study ranged from 15 to 40 F. The week before this sampling, the area experienced some rain and snow that probably tended to hold down the outside dust.

## RESULTS

Table 1 shows microbial concentrations per 0.25 cu ft, by functional area, during the inactive and active work periods. During the activity, the heaviest microbial concentration (63 and 55 organisms per 0.25 cu ft air) was encountered in the leveling and metering gate area and rejects hopper area. The lowest counts (15 and 17 per 0.25 cu ft air) were observed in the grinder throwback and premixer areas.

The general distribution of the predominant microbial types encountered in the different sampling areas differed rather markedly. Thus, Staphylococcus aureus and alphahemolytic Streptococcus, which are usually

TABLE 1. MICROORGANISMS ASSOCIATED WITH COMPOST OPERATIONS DUST

| Sampling area | During inactivity colonies/0.25 cu ft | | | | | | During activity colonies/0.25 cu ft | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Staphylococcus aureus | α-hemol. Streptococcus | Gram-positive bacilli | Gram-negative bacilli | Fungi | Total | Staphylococcus aureus | α-hemol. Streptococcus | Gram-positive bacilli | Gram-negative bacilli | Fungi | Total |
| Receiving hopper (1) | 2 | 0 | 0 | 2 | 2 | 6 | 7 | 0 | 8 | 5 | 9 | 29 |
| Leveling and metering gate (3) | 5 | 0 | 4 | 6 | 2 | 17 | 22 | 5 | 11 | 14 | 11 | 63 |
| Hand picking (6) | 2 | 0 | 1 | 3 | 8 | 14 | 8 | 1 | 8 | 15 | 14 | 46 |
| Rejects hopper (5) | 3 | 0 | 3 | 2 | 4 | 12 | 15 | 3 | 18 | 11 | 8 | 55 |
| Grinder throwback (8) | 1 | 1 | 2 | 1 | 3 | 8 | 5 | 0 | 6 | 2 | 2 | 15 |
| Premixer (9) | 3 | 0 | 4 | 4 | 2 | 13 | 1 | 1 | 7 | 5 | 3 | 17 |
| Postmixer (9) | 3 | 0 | 2 | 1 | 3 | 9 | 10 | 3 | 12 | 5 | 4 | 34 |
| Ground-waste transfer (11) | 2 | 1 | 3 | 2 | 3 | 11 | 12 | 1 | 5 | 10 | 6 | 34 |
| Windrow (7 day old) | 4 | 0 | 5 | 5 | 2 | 16 | 5 | 2 | 18 | 10 | 3 | 38 |
| Curing and storage | 2 | 0 | 0 | 2 | 1 | 5 | 8 | 2 | 11 | 2 | 2 | 25 |

considered to be human borne, predominated in the leveling and metering gate, the rejects hopper, the post mixer, and the ground-waste transfer areas. Staphylococcus aureus was isolated from all areas sampled. The highest count of dust-borne fungi and gram-positive bacilli was observed in the rejects hopper area of the processing building. No attempt was made to characterize gram-positive bacilli and fungi; gram-negative bacilli were classified under genus Pseudomonas and genus Proteus. No coliform organisms were isolated.

# DISCUSSION

When discussing data of the kinds presented here, it is probably most useful to discuss them in relation to other environmental conditions.

Comparative data from airborne microbial populations in various environments (Winslow, 1926) per 1 cu ft air are shown below:

| Environment | Total microbial levels (colonies per cu ft air) |
| --- | --- |
| Country air | 56 |
| General offices and schools | 95 |
| City streets | 72 |
| Factories | 113 |

The levels of microorganisms in the leveling and metering gate and in the rejects hopper areas were twice as high as those in factories. There were, however, no significant quantitative differences in microbial levels between the other composting plant areas sampled and the factories.

The values obtained for dust microorganisms in this composting plant were very low compared with the six municipal incinerators investigated in a previous study (Peterson, 1971). The dustiest area of the municipal incinerators had a total count of 197 colonies per 0.25 cu ft air. In contrast, the dustiest (leveling and metering gate) area of the compost plant had a value of 63 per 0.25 cu ft air. Other studies (Randall and Ledbetter, 1967) have shown that air over an activated sewage sludge waste treatment unit may contain from about 8 to 1170 microorganisms per cu ft, with enteric organisms constituting 19% of the total.

The fact that sewage sludge was used in the process suggested the possibility that enteric organisms might be disseminated into the air. That there were no coliforms isolated in the sludge-handling areas was rather surprising. The absence of coliform organisms in sludge-handling areas may possibly have been the result of careful housekeeping and properly designed operational system. To these factors can be added such considerations as the particle size of the contaminants, which determines the rate of sedimentation, and environmental factors such as temperature, humidity, and air currents.

The distribution of staphylococci and streptococci was also of particular interest. These organisms predominated in the leveling and metering gate, the postmixer, and the ground-waste transfer areas; small numbers were isolated from six other sampling sites. _Staphylococcus aureus_ was isolated from all sampling sites. Staphylococci can survive for long periods in dry air and can easily be transported through the environment by the movements of air currents.

In summary, the values reported are intended to serve as a rough indication of the air microflora that is constantly changing because of the movement of air currents and the settling out of particles. Somewhat higher microbial counts would be expected during spring, summer, or fall. The relatively clean waste handling operation at the Johnson City Plant reflected the newness of the plant, the excellent housekeeping, and the relatively small quantities of waste being handled at sampling time. Even though the operation is comparatively clean, however, the possibility of health hazards should be carefully considered. Using face masks is recommended in areas of heavier contamination.

If, in the future, epidemiological justification for implementing microbial control measures for solid waste-borne aerosols becomes evident, this report might serve as a guideline of feasibility. The techniques used in this study indicate the parameters which must be considered in a monitoring program.

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16. Abstracts

To help evaluate the effects of solid wastes handling and processing on the microbial quality of the environment, a quantitative study was made of the microbial flora of the dust in and around a municipal solid waste-sewage sludge composting plant. Air samples were taken with an Andersen volumetric sampler used in conjunction with trypticase soy agar that contained 5% sheep blood and with eosin methylene blue agar. Sampling was carried out during the inactive and active work periods. Samples were obtained from ten different areas at a height of 5 ft. The highest total microbial counts of 63 and 55 per 0.25 cu ft of air were obtained in the leveling and metering gate area of the receiving building and in the rejects hopper area of the processing building. *Staphylococcus aureus*, gram-negative bacilli, gram-positive bacilli, and fungi were present in all areas sampled. No coliform organisms were among gram-negative bacilli.

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Sewage sludge, *Municipal solid waste, Environmental air concentrations, Microbial flora, Andersen volumetric sampler, Trypticase soy agar, Solid waste management, *Staphylococcus aureus*, Gram-negative bacilli, Gram-positive bacilli

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