Engineering for Microbiological Environmental Control in Refuse Composting

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Biological decomposition of organic matter has probably ocurred in nature since life first appeared on our planet. It results in enrichment of the soil as well as disposal of accumulated organic materials. In recent times, systematic decomposition has been considered for use in the disposal and reclamation of the organic wastes produced by municipalities.

This adaptation of biological processes has been termed "composting" and the final product is called "compost."

Composting involves the setting up of conditions more favorable for biological activity than those found in nature. The establishment of conditions for maximum decomposition include making nutrients readily available and supplying moisture, oxygen, and heat. If the system is to be practical for disposal and reclamation by cities, it must be sanitary, economical, and produce an end product of value to agriculture.

Such a system has been sought by those concerned with the problem since Sir Albert Howard (1935) developed the Indore Process over 30 years ago. This process involved the systematic piling of vegetables and animal wastes in open pits. It included moistening of the material and turning for aeration. For a number of reasons, this process is not suited to conditions as found in the United States. It is, however, widely used in India, where in 1951 there were 138,000 villages in rural areas composting their wastes.

The work of Sir Howard and the success of the process has encouraged work in the field of composting by others. At the present time, there are cities in Great Britain, most of the countries of western Europe, South Africa, Central America, and Japan, which are disposing of some of their municipal wastes through composting. The processes they are using include adaptations of the Indore Process as well as various mechanical innovations designed to improve the aesthetics of the process or to speed it up. These methods are not directly applicable to the United States because of dissimilarity in the nature of the refuse to be composted; differences in the psychology of the public with respect to space, time, mechanization; and need and use of the product. A need for new methods of disposal by our cities has recently become urgent and the shortage of organic matter in the soil has become a matter of increased concern.

Although early composting processes proposed in this country were of dubious scientific and practical value, some universities have conducted creditable research on the composting of municipal refuse. The Sanitary Engineering Research Project of the University of California was conducted over a three-year period, and it found that a wide variety of wastes could be composted successfully (Anon., 1953). Michigan State University also has conducted research on the composting of municipal garbage or swill. Neither of these projects developed a commercial composting process, having been exploratory in nature. Also, the more recent study of Wiley and Pearce (1955) secured basic information, but did not attempt a commercial operation.

The purpose of this paper is to report on a unique process which has been developed from the research of a company in Oklahoma. Investigation began in the late forties, and an intensified program to develop a commercial process has been in progress since early in 1954.

They began with an open windrow method, which is a modification of the Indore Process, but decided that this system was impractical here. Moreover, no machinery had been developed to handle efficiently the wide variety of material found in municipal wastes. Since decomposition is primarily a biological process, it was reasoned that a practical system would require engineering for maximum environmental control with provisions for economical materials handling to keep the cost of the process competitive. High sanitary standards were also a major consideration. On these premises, extensive research and development were begun on basic machinery and a practical process.

A pilot plant using the new process was put in operation at Norman in the fall of 1955. A full scale commercial plant is now under construction. Although investigations of composting agricultural and industrial wastes have been conducted in the pilot plant, the primary concern was the decomposition of the mixed refuse which is normally collected by city garbage trucks. This material was found to have a carbon-nitrogen ratio and pH within ranges satisfactory for composting.

In the "Naturizer Process," the raw refuse is received from the trucks in an enclosed storage conveyor. From there it moves across a picking conveyor where salvable items (metals, corrugated cardboard, clean rags, and newsprint) are removed. The last three items can be composted if desired. Salvage represents about 25% of the incoming material. Its removal serves to increase the amount of refuse disposed of for a plant, and the return from salvage pays a large portion of the entire operation expense of the plant.

The remainder of the raw material passes into a machine called a Pulverator. This machine was designed to mix the material thoroughly, to make it more homogeneous, and to introduce the moistening agent.

Since the raw material coming from the trucks contains about 25% moisture, additional liquids must be introduced to bring it up to the range found most suitable for bacterial activity, 50 to 70%. Moisture in the form of water, raw sewage—sludge, or swill may be used. Disposition of these other municipal wastes, while creating a more valuable end-product and saving water, is a most attractive possibility.

The next piece of machinery in the process is a grinder, whose function is to make the nutrients more readily available for biological activity. It was found that grinding of raw refuse produced a number of beneficial results. Added surface is exposed in this ground refuse, and the material, particularly vegetable matter, is rendered more susceptible to bacterial invasion. The aggregate size is adjusted by the grinder to allow for adequate pore space which traps enough oxygen to maintain biological action for at least 24 hours.

Grinding of raw refuse has been one of the most persistent problems in attempting high rate composting, since no grinder on the market can handle this refuse without excessive wear or break-down. The grinder developed at Norman successfully reduces all of the incoming material except large pieces of metals, which pass through without damage to the equipment.

The moistened, ground material is conveyed into the Digester where the actual decomposition takes places. This equipment was designed to give maximum control over temperatures and aeration while maintaining the favorable moisture conditions which had to be set up.

It was found that thermophilic aerobes were most effective in the breakdown of refuse. With sufficient volume of material and some initial insulation, the temperatures developed in the digester cells have reached as high as 176 degrees Fahrenheit. A temperature of from 140 to 160 degrees Fahrenheit is maintained for three to six days by regulating the flow of air through the cells. Temperatures in this range are not only favorable for thermophilic activity but, according to a study reported by the University of California's Sanitary Engineering Research Project, are above the thermal death points for common plant and animal pathogens, an essential health consideration.

The activity of aerobes rather than anaerobes is necessary for rapid, muisance-free decomposition. Foul odors frequently associated with decomposition are the result of anaerobic activity. With adequate aeration, there are no objectionable odors connected with composting municipal refuse.

Aeration is achieved in the Naturizer Process by a series of cells which allow an exchange of gases on three sides of the mass of material. To further insure adequate aeration, the cells are dropped every 24 hours and the material fluffed up to trap additional air in the spaces between the particles.

It was observed, however, that after 72 hours, biological activity, as indicated by temperature and CO_2 production, declined. It was found that regrinding caused the activity to increase again. This indicated that the opening up of new surfaces to biological attack resulted in this increased activity, and regrinding at the end of 72 hours was incorporated into the process. At the end of two such 72-hour periods in the Digester, it was found that a marketable product was produced. It is dark in color with about the same texture as leaf mold or well-rotted manure.

Actually a humus, compost from municipal refuse benefits the soil by increasing its water-holding capacity, promoting better aeration, improving its structure, increasing its buffering capacity, and adding essential trace minerals and other plant nutrients.

It is anticipated by those who have developed this process that through an engineering approach to a biological problem, a solution has been found which will allow cities to dispose of their wastes in an economical, nuisance-free manner and make possible the return of this valuable organic matter to the land.

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