# IRCWD NEWS

WHO International Reference Centre for Wastes Disposal

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## The Problem of Hazardous Substances in Municipal Wastes Composting

The following is a translated excerpt from the paper "Kompostierung von Siedlungsabfällen – ein wertvoller Beitrag zum Recycling" (Municipal Wastes Composting – A Valuable Contribution Towards Recycling) published in Müll und Abfall 3/75 by Dr. Georg Farkasdi, Institute for Agricultural Microbiology, University of Giessen, Federal Republic of Germany.

The question of how to treat the heavy metals and non-biogenic, organic toxic materials that find their way into compost through municipal wastes has become a central issue in industrialized countries. Unfortunately, the solutions possible for disposal plants that treat both industrial and household wastes are usually complicated and expensive. Such problems should be taken into account when new facilities are planned.

Composting as an urban waste disposal method is a technically controlled, biochemical process by which the organic waste mass is converted into a humus-like substance (1). This fermentation process takes place in the presence of air; it is brought about by microorganisms of all kinds: bacteria, fungi and actinomycetes. By means of enzyme activity, they break down complex organic compounds, extracting the energy necessary for catabolism and releasing heat. At the same time these microorganisms use previously decomposed material or fresh organic substances to build up their own cell substance. In this case, anabolism i.e. the reverse process takes place; simple inorganic or organic substances are converted into new complex organic compounds.

Various phases of biological degradation can be discerned during the fermentation process. Omnipresent, simple microbe species begin decomposing the organic mass, degrading the compounds to a certain degree; other, complementary groups continue the process. Thus one group creates the environment necessary for the activities of the next.

In other words, decomposition consists of a number of separate, biochemical processes that follow each other in interdependent succession or take place simultaneously. It is governed by very specific laws which have not, as yet, been fully explored.

These facts allow us to conclude that fermentation can be accelerated to a certain extent by creating optimum conditions for microorganisms. That suitable technical measures will enable the production of a well-fermented, mature compost within 24 hours will, however, always remain wishful thinking. The result of very intensive but brief pre-fermentation is what is called fresh compost, a product that has many uses but which is still far from mature. Much of the organic matter is still undecomposed and contains very little valuable, stable humic material.

The main problem in waste management is how to dispose of urban refuse hygienically and without detriment to the environment. Wastes disposal must be planned with the health of man and animals in mind.

What health hazards do wastes present? They may well contain pathogens or noxious materials.

Formerly, only pathogens and parasites were believed to have a bearing on the hygienic quality of compost. Yet, solid wastes, especially household refuse and street litter, although fairly safe for man and animals, may contain plant pathogens. In addition, market and slaughterhouse wastes as well as wastes from hospitals and medical practices must be regarded as potential carriers of infectious germs.

A veritable concentrate of pathogens can be found in sewage sludge, since all human and animal excrements ultimately reach our waters. The greater the efficiency of a purification plant, the more pathogens are sedimented in sludge. Yet conventional sludge treatment methods provide only a reduction in the number of pathogens.

As long as certain conditions, which must be determined through practical experiments for each specific composting method, are observed and optimum moisture content of the initial material, aeration, fermentation temperature and time are provided, aerobic heat fermentation kills off the pathogenic germs. Toxic wastes, on the other hand, have become an issue only very recently.

However, the term "hazardous substances" (Schadstoffe), which has become almost a catchword among experts, is based on fallacious reasoning. A substance is neither toxic nor beneficial in itself; the dose makes it toxic or beneficial (Paracelsus). Almost every mineral can be considered a micronutrient as long as the corresponding maximum concentration is not exceeded. Since the term hazardous substances has been accepted as common usage it may be adopted in the sense of inorganic or synthetic organic substances not belonging to the natural ecosystem. (Biogenic toxins are left aside as they are likely to deteriorate during the fermentation process).

The non-biogenic substances can be subdivided into inorganic toxic material, such as heavy metals, and organic substances such as carcinogenic, polycyclic, aromatic hydrocarbons (i.e. 3.4 benzpyrene and 3.4 benzfluoranthene) and the polychlorinated biphenyls (PCB). These hazardous substances in wastes, wastewater and industrial exhaust air wind up in municipal refuse and sewage sludge. Since heavy metals and PCBs are used to manufacture consumer goods they may also end up in urban wastes in small quantities.

Heavy metals are ubiquitous. Some, such as zinc, copper, iron, manganese, cobalt and molybdenum are indispensable to the metabolism of all living organisms, while others, such as lead, mercury and cadmium, even in small doses, are toxic to man and animals; these could be called the undesirable heavy metals (2).

In judging the effects of urban composts and sewage sludge on the heavy metal content in the soil, total content is often mistakenly equated with the quantity available to the plant. Kick (3), however, maintains that only 10% of the total metal content is available to plants.

The solubility of heavy metals in the soil depends on many factors. It decreases, for instance, with increasing pH factor and increasing quantities of carbonates and other bases. Heavy metal intake is also impeded by a high proportion of organic material and clay. In general, composts are rich in carbonates and organic material and tend to be alkaline. When calculating the amount of toxic material that would reach the soil through the use of compost, it should be borne in mind that there is an increase not only in toxic substances but also in soil substance.

Absorbable heavy metals (there are far fewer than non-absorbable metals) are not totally absorbed by plants either. Absorption, rather, is dependent on the type of plant, climate and other factors.

Much of what has been said also applies to toxic organic wastes, with the exception that we know little about their origin, spread an effect. Polycyclic aromatics, for example, are produced when organic material is heated to over 500 °C and during ordinary incineration. We do not know, however, whether they can be synthesized by various types of plants. We know that they are discharged into the atmosphere together with the emissions from internal combustion engines, heating systems and incineration plants and reach the soil via precipitation and sedimentation. Not known is what changes they undergo in the soil, that is, whether they are accumulated or broken down by microbial action. The conditions under which plants absorb soluble polycyclic compounds – whetherabsorption is proportionate to the quantities available in the soil or not – are also unknown. Then, too, they are known to be carcinogenic if inhaled or applied to the skin as was proven in experiments. On the other hand, do they have the same effect on man if ingested? Insufficient note has been taken of the mutual influence the various polycyclic compounds can exert on each other. Experiments under way at the Institute of Hygiene of the University of Mainz show that the concomitant application of carcinogenic and non-carcinogenic aromates on laboratory animals usually reduces the incidence of cancer.

Test results have also revealed that high concentrations of hazardous substances in the soil do not correspond to the highest amounts found in plants. In some experiments the plants of the unfertilized control lot proved to have the highest 3.4-benzpyrene concentration while the lowest was found where compost was used as a fertilizer. In one case the highest concentration of 3.4-benzpyrene was discovered in plants grown on barnyard manure.

It has also been ascertained that the absorption of hazardous substances varied not only according to plant species but also according to a plant's particular growth phase. Moreover, toxic substances accumulate in different parts of the plant depending on the species; thus, in the case of radishes and red radishes, the roots contain only 10% of the polycyclic compounds found in the leaves (4).

In Müller's study (5) on the effects of saprophytes on polychlorinated biphenyl (PCB) it is shown that this widespread pollutant represents a threat to life even in minimum ppm concentrations. Its great thermal and chemical stability and low solubility in water reduces its susceptibility to microbial degradation. These physical and chemical properties make PCBs ideally suited for use in the electronics industry as well as for varnish and plastic manufacturing. When composted together with regular wastes, these PCBs remain practically unchanged by the process and thus increase the concentration of toxic materials in compost.

To conclude from this that composting is unsuited as a waste treatment method would, however, be competely wrong. Those authors who so unfortunately condemn composting forget or, perhaps, consciously choose to ignore the fact that other disposal methods such as landfilling or incineration cannot do away with toxic materials either: they cannot eliminate noxious substances, they merely transfer them from one medium to another. Some materials are discharged into the atmosphere while others appear, highly concentrated, in the percolating waters of landfills. In short, these toxic substances are never removed from the biological cycle. Thus the problem posed by hazardous wastes cannot be solved by disqualifying composting as a wastes disposal method.

The answer, on the contrary, lies in replacing heavy metals and polychlorinated biphenyl with more easily recyclable substitutes wherever possible. Those products for which such non-renewable materials are indispensable should not be composted. The same applies to the sewage sludge of municipal wastewater systems into which toxic wastes have been discharged.

*Editor's note: In industrialized countries treatment of both domestic and industrial wastewaters in one and the same system is an established fact. To undo this and create two separate networks would entail considerable financial and technical problems. Developing countries that have not already made this mistake should provide for the separate treatment of domestic and industrial wastewater. An exception can be made for food-processing industries or branches that produce biogenic products (canned food, dairy products, fodder, wood processing). On the other hand, new wastewater treatment plants should be planned near refuse composting facilities, since the combination of refuse with its high carbohydrate content and sewage sludge, which is rich in nitrogen, is ideally suited for composting.*

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## Note on Compost Quality

The following compost quality standards were adopted at a meeting of the Swiss composting plant operators. The meeting was held in Zurich on 26 September 1972.

| | |
|---|---|
| *1st quality* (mature compost only) | Maximum moisture content 35%<br>Maximum foreign particles on an 4-mm screen 1%<br>Volatile substance according to the Fertilizer Handbook min. 10% |
| *2nd quality* (mature compost only) | Maximum moisture content 40%<br>Maximum foreign particles on an 6-mm screen 1%<br>Volatile substance according to the Fertilizer Handbook min. 10% |
| *3rd quality* (both mature and fresh compost) | Maximum moisture content 45%<br>Maximum foreign particles on an 8-mm screen 1.5%<br>Volatile substance according to the Fertilizer Handbook min. 10% |

# Decontamination by Composting

The following is the translated paragraph on "Entseuchungseffekt" from the article "Vor- und Nachteile der Kompostierung aus der Sicht der Hygiene" (Advantages and Disadvantages of Composting from the Hygienic View Point) published in Stuttgarter Berichte zur Abfallwirtschaft Vol. 6, part II, 1975 by Prof. Dr. K.H. Knoll, Justus-Liebig University, Giessen, Federal Republic of Germany.

Microbial, aerobic fermentation is an exothermic process in which organic substances are degraded in biochemical reactions while pathogens are killed off. This elimination of pathogens is attributed to the following factors:

- the rapid proliferation of physiological, non-pathogenic microorganisms to a germ count of between $10^8$ to $10^{10}$ per gram of material
- biogenic heat production and
- the antibiotics produced by those microorganisms which destroy even heat resistant pathogens.

Anthrax, for example, remains virulent in the soil for decades thanks to the resistance of its spores, which can withstand exposure to 140 °C air for 3 hours; it is, however, completely annihilated during fermentation since the slow increase in temperature characteristic of biogenic heat production causes the spores to germinate into a vulnerable vegetative state. Hence, composting is ideally suited for the treatment of infectious wastes and can be effectively used to decontaminate municipal sewage sludge. It also follows that the aerobic fermentation of sewage sludge together with household refuse is advantageous not only because it provides for better fermentation and compost quality with regard to its C/N ratio but also because it produces a germ-free product. Note must be taken of the fact that no additional energy need be expended for decontaminating the potentially infectious sewage sludge since this is brought about by microbial action. Depending on the treatment method chosen, decontamination time can be influenced by applying greater technical input which, however, cannot exceed the biological limits of fermentation.

All urban waste composting processes are characterized by 4 fermentation zones corresponding to different temperature regions which comprise microorganism species of varying activity. Decontamination can take place only where the exothermic fermentation temperature exceeds 45 °C. Moreover, this occurs only under optimum conditions: C/N ratio below 35:1, initial water content 45 to 55% and an adequate air supply. Provided these conditions are observed, material in open windrows turned once is decontaminated after 21 days of fermentation; this time can be reduced further to a few days in facilities where optimum conditions are provided. However, regardless of the process chosen, decontamination time will always be determined by hygienic demands which, in turn, are based on the length of time needed to kill off resistant animal pathogens. The technology of various composting methods, their effectiveness and the point at which urban wastes are decontaminated can be assessed on the basis of the hygienic-bacteriological quality index (see table 1). An examination of a series of different composting methods has revealed that urban wastes can be completely decontaminated if the hygienic conditions in the quality index are observed.

# Periscope

## India

This is a summary of "Coagulant from Red Sorrela Seeds" published in the *Technical Digest* No. 49, July 1975 by the National Environmental Engineering Research Institute, Nagpur, India.

Red sorrela seeds (RSS) were discovered to be an effective coagulant. The RSS powder when mixed with sodium carbonate and boiled in water develops a property to flocculate clay suspension. *It acts as a coagulant and the addition of conventional alum is not necessary.*

After the RSS seeds are cleaned of fibrous material they are pulverized and the powder thus obtained is sieved to remove the husk. It is then mixed in the proportion of nine parts of powder to one part of commercial sodium carbonate by weight. One gram of the mixture is thoroughly mixed in about 500 ml water and heated; boiling for a minute is not harmful but is not usually required. The volume of the milky suspension is made up to one litre and is used as a coagulant. The dose is calculated as 1.0 ml equivalent to 1.0 mg coagulant.

Experiments were carried out to determine the efficiency of thiscoagulant. A dose of 2—100 mg/l was used for a raw water turbidity between 45 and 7600 units.

A dose of 10 mg/l of ortho, meta, pyro and tripolyphosphates did not effect the coagulation adversely. The settled water was suitable for standard filtration. Filtrate turbidity was below 3 units.

To summarize, RSS is a potential coagulant for removal of turbidity from water. The coagulant can be prepared easily. The seeds are available all over India. Also, the plant can be cultivated for abtaining these seeds. RSS as a coagulant has potential use in rural areas.

Table 1

**Hygienic and Bacteriological Quality Index for the Evaluation of Composting Processes (safe for man and animals)**

| Process | Material | Moisture content | Maximum steady temperature | Hygienic evaluation | Note |
|---|---|---|---|---|---|
| *Open-air Composting* | | | | | |
| "Cold composting" in flat windrows | Refuse, sewage sludge | 55 | $46\ ^{\circ}C$ | Unhygienic for 5 months | |
| "Cold composting" in windrows | Sewage sludge | 60 | $52\ ^{\circ}C$ | Unhygienic for 6 months | |
| Composting in windrows | Refuse | 40–60 | $> 55\ ^{\circ}C$ | Germ-free in 3 weeks | Windrow is turned once |
| Composting in windrows | Refuse, sewage sludge | 40–60 | $> 55\ ^{\circ}C$ | Germ-free in 3 weeks | Windrow is turned once |
| Windrow composting with additional aeration | Refuse, sewage sludge | Hygienic investigations have not been completed | | | |
| *Systems composting* | | | | | |
| Mobile fermentation drum | | | | | |
| Rotary drum (example: Dano process) | Refuse | 45–55 | $> 60\ ^{\circ}C$ | Germ-free in 6–7 days | One additional week of windrowing is needed for spore elimination |
| Rotary drum | Refuse, sewage sludge | about 50 | $> 60\ ^{\circ}C$ | Germ-free in 6–7 days | |
| Fermentation tower with vertical rotary axix (example: Earp Thomas process) | Refuse | 40–50 | $> 65\ ^{\circ}C$ | Germ-free in 1 day | One additional week of windrowing is needed for spore elimination |
| Fermentation tower | Refuse, sewage sludge | 45–55 | $> 65\ ^{\circ}C$ | Germ-free in 1 day | |
| *Stationary fermentation unit* | | | | | |
| With aeration and turning | Refuse, sewage sludge | Hygienic investigations have begun | | | |
| *Other processes* | | | | | |
| Capillary drying process (example: Bricollare process) | Refuse, sewage sludge | 40–55 | about $60\ ^{\circ}C$ | Germ-free in 3 weeks | |

# News from WHO

## New WHO publication

*"Community Wastewater Collection and Disposal", by Daniel A. Okun & George Ponghis. Geneva, World Health Organization, 1975. 287 pages. Price: Sw.fr. 42.– French edition in preparation. Available through WHO sales agents.*

Continuing the series of WHO guides on basic sanitary services, this publication describes in simple terms the fundamental principles and practices for waste water collection and disposal that are likely to be most appropriate for developing countries. Relatively little has been done in this field; design standards need to be developed in the light of special requirements and local conditions when communities recognize the need for a public wastewater collection and disposal system to replace the individual privies, cesspools, septic tanks, and similar constructions or the almost complete lack of sanitary facilities existing in many countries. The various chapters of this manual deal with such aspects of sewerage systems as financing and administration, theory and design, and operation. A wealth of line drawings (over 80 of them) illustrate and extend the descriptions, and technical data needed by the planner and engineer are given in a large number of tables. An extensive list of references to important information sources is contained in the publication.

## New Publication

The National Environmental Engineering Research Institute (NEERI) in Nagpur, India, has brought out a new publication entitled "Indian Literature in Environmental Engineering, Annual Bibliography 1972".

Besides details of papers presented at 43 conferences, symposia and seminars, this publication contains bibliographical details of 968 papers published in 84 Indian and 8 foreign periodicals. This comprehensive bibliography enables the user to get a bird's-eye view of the contribution which India made in the field during the year 1972.

# Abstracts

The following abstracts have been taken from our documentation on solid wastes which contains at present over 2600 publications.

*Golueke, C.G.:* Biological reactions in solid waste recovery systems, 1974, *15,* No. 3, 2–6, Compost Science.

This review attempts to establish a background for the basic biological reactions involved in solid waste treatment. It is shown that biological systems accomplish waste treatment by way of transformation of the wastes to a stable form or by consumption to produce a new substance. In so doing, a useful product or products usually result. An example of transformation is composting. Examples of consumption are anaerobic digestion, hydrolysis of cellulose, and photosynthetic reclamation. Useful products of biological systems can range from a soil amendment material to proteinaceous feedstuffs and fuel (ethanol and methane). Genetic and physiological limitations of the microorganisms involved are the ultimate constraints on biological systems. These constraints can be compensated somewhat, but not removed, by sophistication of equipment and operation.

*Bezdicek, D.F.:* Recycling pollutants and unused resources on a golf course, 1974, *42,* No. 8, 24–28, Golf Superintendent.

To serve the greatest number of people in their needs for recreation and leisure activities, golf courses tend to be located in areas of dense population. Such areas also see large amounts of pollutants and unused resources resulting from automobiles, industry and the urban community, and the production of sewage and solid wastes is correspondingly high. This paper shows how golf courses offer an excellent opportunity to recycle a portion of these pollutants and unused resources.

*Hasuk, A., Ernst, A.:* Prevention of anaerobic zones in compost stacks, 1974, *6,* No. 5, 133–140, Müll und Abfall.

Secondary decomposition of compost from garbage produces slightly anaerobic zones. The result may be troublesome odors and inhibition of growth. Experiments show that fourfold turnover of the compost stacks only 0.5 m high in the first month of the three month secondary decomposition with a disc plough prevents the formation of such zones.

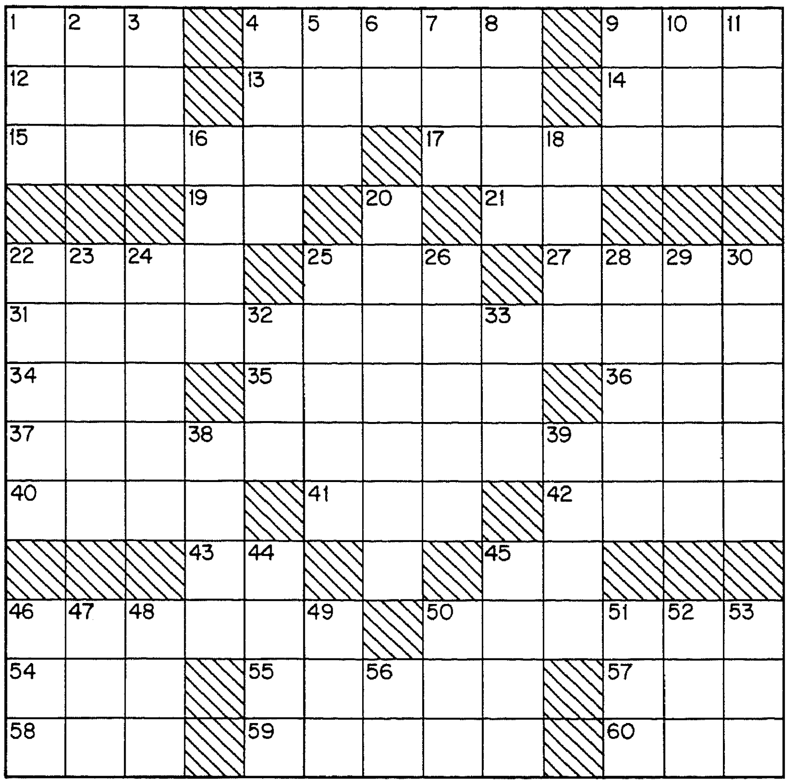
*Poincelot, R.P.:* A scientific examination of the principles and practice of composting, 1974, *15,* No. 3, 24–31, Compost Science.

Considerable interest has developed in composting as a means of solid waste disposal. The increase in costs of fertilizers and the need for soil conditioners with some unproductive infertile soils also stimulate additional interest in composting. This paper examines the biochemical and microbiological aspects of the interior of the compost pile in order to better appreciate how the optimal conditions for producing compost are determined. A short history of the science of composting is also presented.

*Hammond, B.:* A glint of gold beneath the rubbish tip, 1975, No. 53, 49–52, Vision.

Both industry and government in many parts of the world are examining ways of economizing on increasingly expensive raw materials and systems to retrieve them. More and more firms are beginning to find that recycling can be profitable as well als socially desirable. This paper briefly surveys a number of techniques recently developed in Europe for reclaiming materials, both industrial and domestic.

## Pollution Puzzle



Across:

1. Small seed
4. Saclike structures in plants or animals
9. Biochemical oxygen demand (abb.)
12. Japanese plant with edible shoots
13. A wary look
14. River in North Riding, Yorkshire, U.K.
15. Fish
17. Solar . . . . . .
19. Depletion in eutrophic lakes (symbol)
21. Ethyl (symbol)
22. Small town on the Velikaja River, U.S.S.R.
25. Channel
27. Hooked nail
31. Bacteria gourmet
34. Range of hills near Hamelin, northwestern Germany
35. Boil with indignation
36. Small town near Poona, western India
37. Antiseptics
40. Small seaport on the boundary river between Turkey and Greece
41. German abb. for baron
42. Strong alkaline solutions
43. Beryllium (symbol)
45. Sea level (abb.)
46. Definite quantity
50. Pollutants in the gas stream of the incinerator and stack
54. Period of time
55. . . . . . rubber
57. Anger
58. Skin tumor
59. Historic Chinese family
60. Undigested sludge

Down:

1. Fluid of an infection
2. Mount Psiloriti in Crete, Greece
3. Petroleum, oil and lubricants (abb.)
4. Water purifying agent (symbol)
5. Monetary unit of Japan
6. Selenium (symbol)
7. A cardinal number in Italian
8. Since
9. Seedcase of a plant
10. Organic (abb.)
11. Former title of the governor of Algiers
16. Shed feathers
18. Engrave
20. Kind of shoes
22. Put up with
23. Basic language
24. German for ox
25. Coarse residue
26. Source of illumination
28. Resembling a lawn
29. Semiprecious stone
30. Wheat beer
32. Eternity
33. Domesticated animal
38. Russian log hut
39. Associate
44. Shield
45. Incineration residue
46. Condensed moisture
47. Mineral
48. River in southern Poland
49. Town on Lake Pielinen, eastern Finland
50. Membranous fish organ
51. Gaseous substance
52. Spanish abb. for Mrs.
53. Chop with an ax
56. A performance (colloq.)

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