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Rough Draft

Translation

PESTICIDES IN COMPOST

Polychlorinated Biphenyls (PCB) Are Barely Degraded During Composting

Translated by Michael Dub, 9 October 1974

The composting of domestic refuse and of settling slurry has still been considered as an ecologically favorable kind of refuse removal, since in the process a natural, biological reaction is imitated with technical processes: the rotting. Investigations at the Society for the Radiation and Environment Research (GSF) have shown that domestic refuse, settling slurry, and refuse compost contain pesticides such as polychlorinated biphenyls (PCB), aldrin, and DDT. It has been unequivocally proved in a simulation plant that these pesticides during composting are almost entirely non-degraded. There is a risk that during application of the compost as a fertilizer these pesticides enter the biological cycle and it can lead to health-hazardous accumulation.

In order to remove or to process the increasing refuse quantities in the most harmless manner, the following requirements must be imposed on such technologies: hygenic, toxicological, and chemical aspects. The hygenic requirement, i.e. the product of the refuse elimination must be free of pathogenic agents. The toxicological aspects mean that the residue must not be poisonous to people, animals, and plants (waste gases from the combustion, slag from the deposits). The ecological aspect encompasses the formation of by-products which should be as small as possible and must not create any danger to the

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environment, such as sulfur dioxide, hydrogen fluoride, and hydrogen chloride, during combustion. The last criterion is the ecological-chemical problem: the products and residues must be quantitatively detected, the distribution and conversion must be investigated. The investigations at the Society for Radiation and Environment Research (GSF) deals particularly with the ecological-chemical aspects of the refuse elimination. It involves the following problems: it has been established that domestic refuse and settling slurry contain above average-high contents of pesticides in the form of residues of the pesticides and insecticides and of other toxicologically dangerous foreign matter that is almost totally resistant to further biological degradation.

What happens with the pesticides during composting? To study this question, Dr. Müller and co-workers at the Institute for Ecological Chemistry (under the leadership of Professor Korte) built a simulation apparatus, for the duplication of the composting process in the laboratory. As is known, during composting by the aerobic decomposition with billions of microorganisms (bacteria and fungi) the organic components of the refuse, with an access of air and a spontaneous temperature increase to about 70°C, are decomposed and are converted into assimilation substances of the microorganisms by their metabolic activities and also into carbon dioxide.

In a large-scale commercial operation this occurs in rotating drums or in stacks with a controlled air and moisture supply. The end product is a finished compost, from which the pieces of glass and plastic particles are removed by sifting, and finally has the appearance of crumbly soil. This refuse compost is supplied as a fertilizer to the agriculture and forestry, to vineyards, horticulture, and municipal undertakings.

It was established in the investigation of residues that refuse composts contain polychlorinated biphenyls (PCB) in considerable quantities in the range of several

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mg/kg refuse. These PCB are extraordinarily stable foreign substances, which are spread all over the world and in low concentrations can be considered as dangerous to living beings. Thus, the MAK value (the maximum working place concentration) amounts to only 0.5 mg/m^2 to 1 mg/m^3, depending on the degree of chlorination.

The various mixtures of the polychlorinated biphenyls are used mainly in the electro-industry as insulating and cooling liquids in the transformers as well as a dielectric in the construction of condensers, in the lacquer and plastics industry as a plasticizer, and in the lift equipment as a hydraulic liquid. In the Federal German Republic since 1972, PCB, because of their high toxicity, may be used only in "closed systems" (condensers, transformers).

Foreign Substances Were Radioactively Marked

In the investigation of the possible degradation of polychlorinated biphenyls, domestic refuse was first finely ground and then was composted in a simulation apparatus. The pesticides under investigation were added to the material in the concentrations which are also encountered in practice, with the concentrations of the substance to refuse quantities in a ratio of 1:1,000,000.

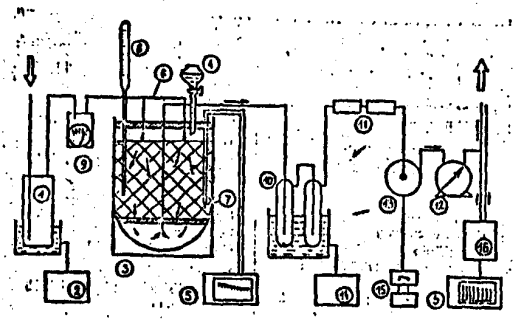
In order to be able to quantitatively follow the location of the pesticides, they were radioactively tagged with ^{14}C. After the composting process, the radioactively marked foreign substances as well as their secondary products were extracted with organic solvents such as ether and methanol. It was possible by means of the scintillation-counters to follow exactly, quantitatively how much of the starting products remained intact and which conversion products were formed. The most important results of the experiments of Dr. Müller are: even the low-chlorinated biphenyls, as they very recently have been developed, survive the composting unchanged, 2,2'-dichlorobiphenyl, for example, in the amount of more than 98%. Likewise, the higher chlorinated biphenyls are not attacked by the microbial degradation.

In a dissertation published at the beginning of the year, Dr. Müller came to the following conclusion: "consequently, the refuse composting at least for the investigated substance classes is not a suitable process for the elimination of refuse. Rather, it should be suspected that the resistant xenobiotics (foreign substances), as for example the PCBs, which already circulate in the ecological cycles, through the use of the composting products (ripe compost, garden mold) will come into the environment through the cultured land and, consequently, will be distributed again in space and can enter in the biological cycle". Moreover, the polychlorinated biphenyls present a problem even in combustion, since they can be decomposed with certainty only at the temperature of about 1000°C.

In order to place the question of the objective environmental harmlessness of different processes for the refuse elimination on a more solid scientific basis, further studies at the Institute for the Ecological Chemistry of the Society for Radiation and Environment Research should clear the question about the behavior of the other widely spread foreign substances during composting: whether plants take up foreign substances from the refuse compost and whether an objective control of the composting can increase the conversion ratio.

By R. B. Firnhaber

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A simulation apparatus for compositing the substances labelled with ^{14}C in the laboratory with (1) air humidifier, (2) thermostat, (3) Dewar container with the composting cell, (4) water container for the regulation of the compost moisture, (5) a recording device, (6) gas inlet with a distributor to 4 nozzles, (7) thermoelement, (8) stem thermometer, (9) hydrometer, (10) cooling trap with 500 ml capacity, (11) activated carbon and silica gel filter, (12) gas meter, (13) vacuum pump, (14) cold bath, (15) switch clock for controlling the combustion process, and (16) CO_2 measuring device.

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