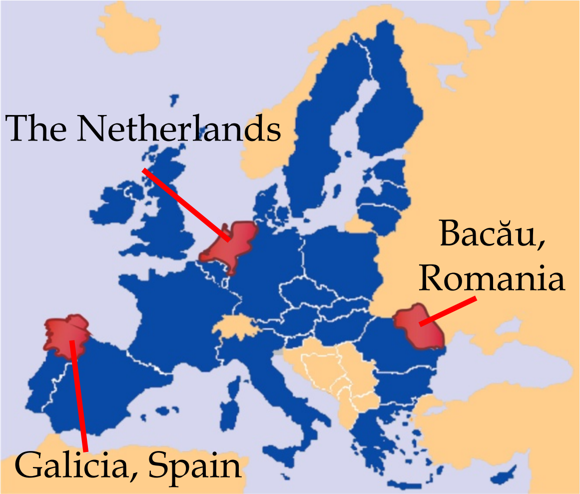

Twinning Project
PHARE RO/06/IB/EN/06
Romania – North Eastern Region

Technical aspects of biowaste composting

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Outline

- Some more theoretical background
- Composting technologies

Definitions - 1*

Composting =

- A controlled, aerobic process
- Taking place at thermophilic temperatures (50-60 ^{o}C)
- Resulting in degradation and stabilisation of organic matter
- By microbial activity.

* Haug R.T. (1993) :The Practical Handbook of Compost Engineering

Definitions - 2*

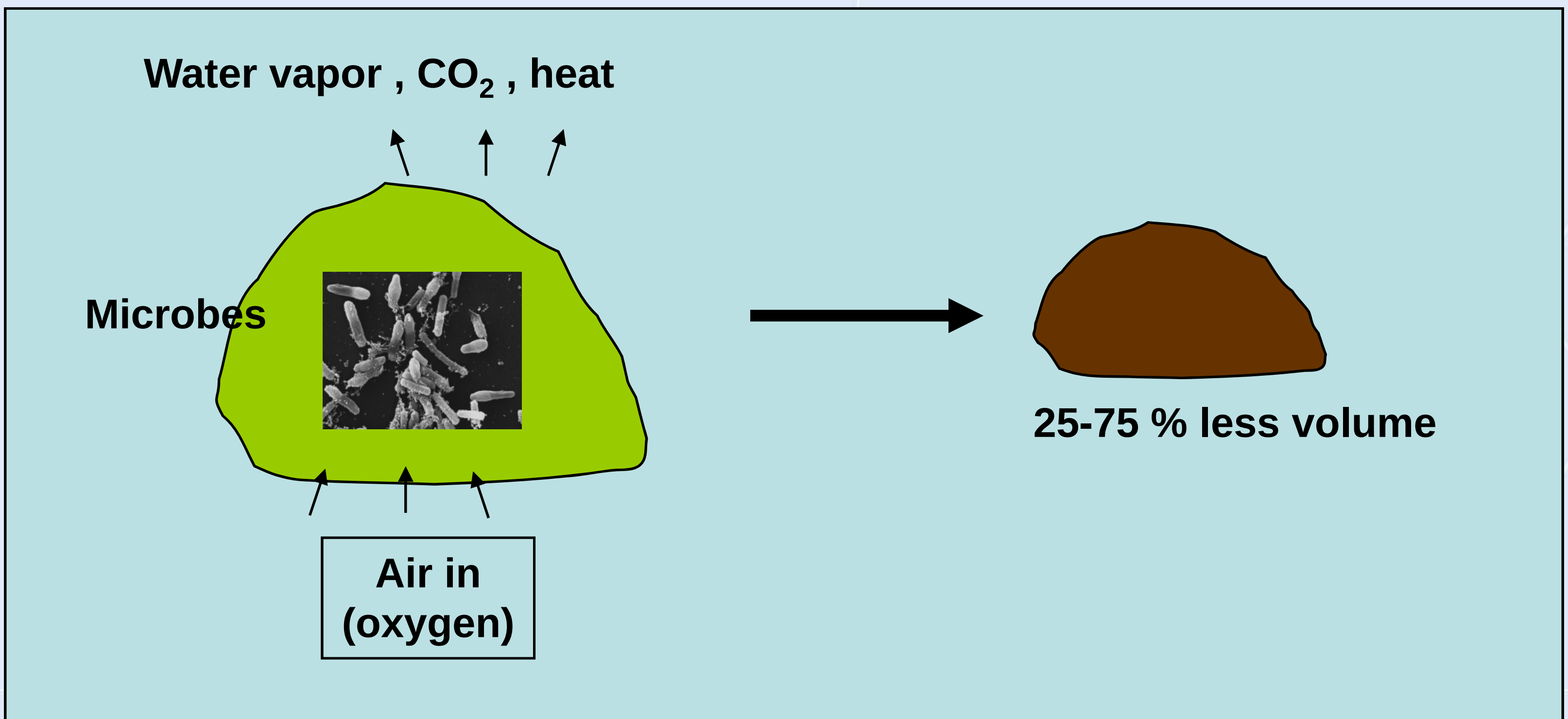
Compost =

- An organic soil improver,
- Stabilised to a humic product,
- Free of pathogens and seeds,
- Not attracting insects and vermin,
- To be stored without producing bad odours,
- Stimulating plant growth.

* Haug R.T. (1993) :The Practical Handbook of Compost Engineering

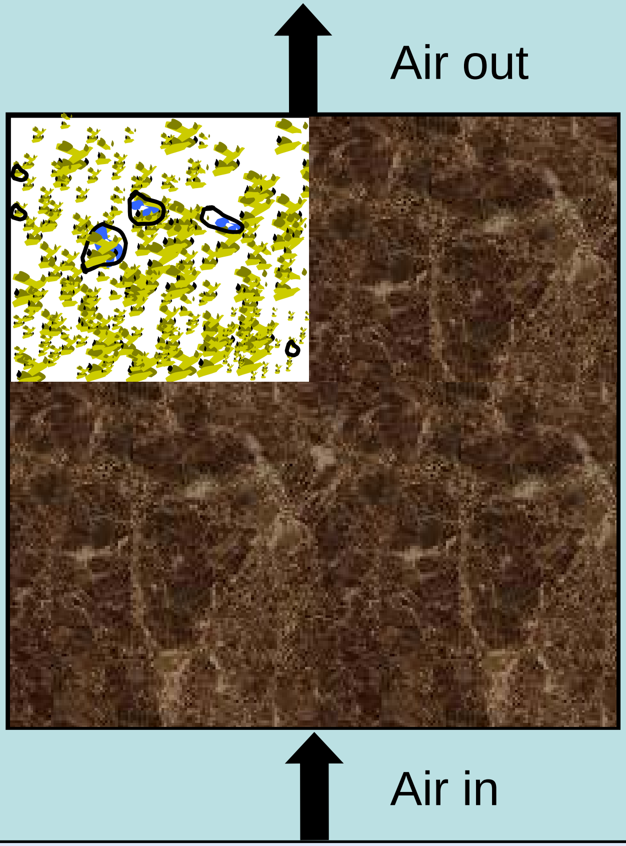
Composting process

Fresh Organic Material → Stabilised compost

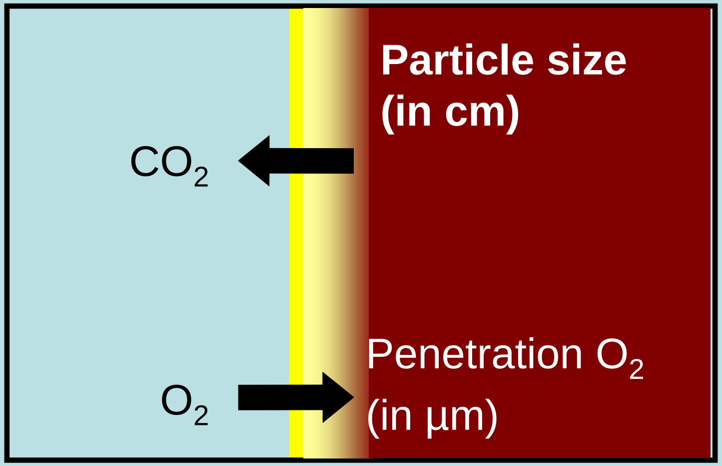


What happens inside the compost pile?

MACRO level



MICRO level



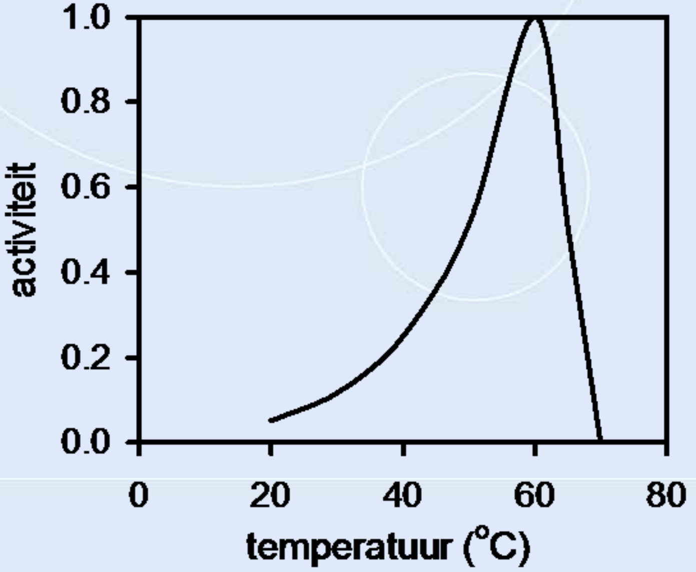
1. Inside particles: anaerobic
   Hydrolysis and Fermentation

2. Interface air-particle: aerobic
   Oxidation of fermentation products

Relevant factors - 1

Temperature

- killing pathogens, plant seeds: >50 ^oC
- degradation rate increases factor 2 every per 10 ^oC
- optimal temperature: 45 - 55 ^oC



Relevant factors - 2

<u>Moisture content of material</u>

- too dry (<20%): no microbial activity
- too wet (>70%): porosity too low, resulting in anaerobic conditions (bad odors and methane)

Relevant factors - 3

Carbon-Nitrogen ratio

- Too high (>30): slow degradation
- Too low (<15): emissions of NH_3 (toxic, bad odor, corrosion)
- Optimal ratio: 20 - 30

Relevant factors - 4

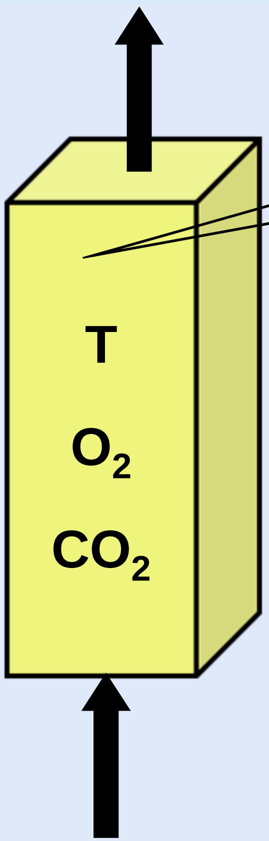
Particle size

- Microbial degradation takes place at surface of particles
- Large particles gives low surface area: slow degradation rate
- Small particles gives high surafce area: fast degradation rate

- However: possibility of anaerobic conditions

Engineering of composting

$OM + O_2 \rightarrow CO_2 + H_2O$ + heat



Temperature = heat supply – heat removal + heat production

O_2 content = O_2 supply - O_2 consumption

CO_2 content = CO_2 production - CO_2 removal

Mechanisms for supply and removal:

- diffusion of air
- convection of air

Air demand for composting

Pile	
Height:	2 m
Density material:	700 kg/m^3
Porosity:	50%
Moisture content:	600 g/kg
Organic content:	240 g/kg

Calculations

⇒ **Air rate for O_2 supply = 8 m^3/m^3/uur at 50 ^oC**

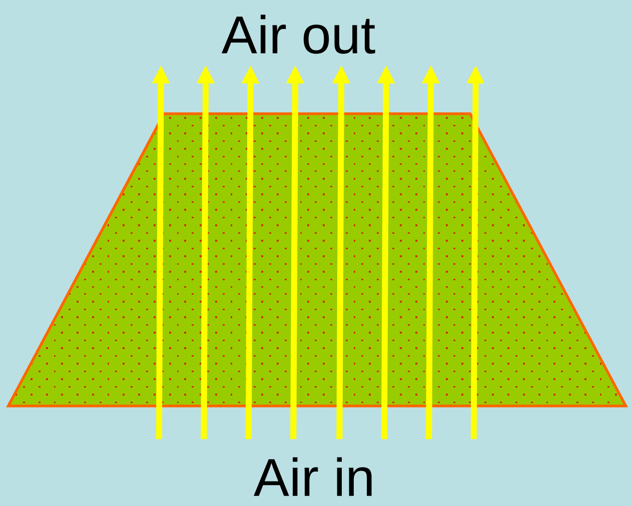
⇒ **Air rate for heat removal = 150 m^3/m^3/uur at 50 ^oC**

Conclusions

- Diffusion is not sufficient
- Turning pile is not sufficient
- **Convection of air through pile is needed**

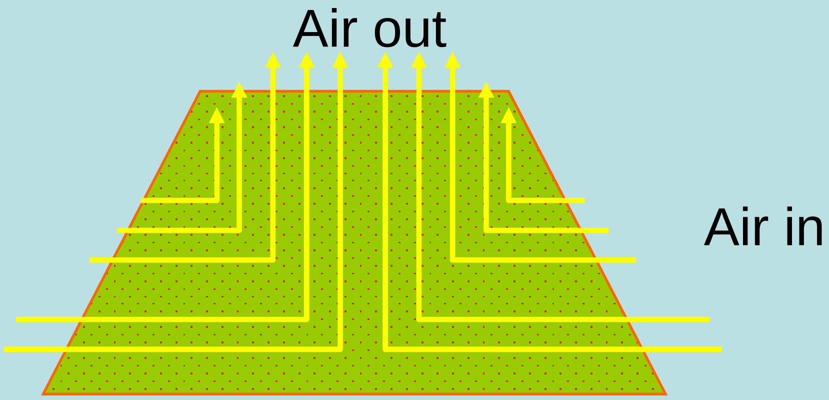
Convection of air through pile

FORCED



Air is blown in by a fan

PASSIVE



Natural convection by difference in air density (warm, moist)

Types of composting systems

Location:

- in open air
- in closed environment
- in reactors

Types of composting systems

Aeration:

- Passive
- Forced

Types of composting systems

Mixing:

- No mixing: static pile
- Periodical turning
- Continuous mixing

Controlling factors

Materials

- Additions
- Return
- Nutrients, C/N
- Initial moisture
- Porosity
- Bulk density
- Particle size

Process

- Temperature, O2
- Aeration scheme
- Mixing
- Controlling moisture
- Length of process
- Length of maturation
- Size, height, shape of pile

In summary

- Micro-organisms do the work
- They need proper working conditions: enough oxygen, proper temperature, enough nutrients
- Controlling: input material, composting process

➢ When taken care of: composting will proceed

Small-scale vs. large-scale - 1

Small-scale	Large-scale
Need for low-tech solution	Require high-tech solutions
Much of the work can be done by manual labor	Need for mechanical equipment as less work can be done by manual labor
Low investment costs	High investment costs
Materials and equipment are simple and can be obtained locally	Part of materials and equipment have to be imported
Need for small land areas	Need for large land areas that are scarce and expensive in large cities
Compost can be used in the local community; less need for marketing	Marketing compost is essential to have revenues from the waste treatment technology

Small-scale vs. large-scale - 2

Small-scale	Large-scale
Small distances for transport	Large distances for transport have to be covered both for waste and product transport
Transport can be done by man driven vehicles	Transport has to be done by motorized vehicles
Operation are done by people who are normally mostly not skilled	Operations have to be done by private companies with skilled personnel
Community-based (local area) activity	Activities typically organized by municipality and private companies
People are involved in MSW management; as a result people are more aware and feel responsible; better opportunity to start source separation of waste	People are not actively involved in MSW management and unwilling to pay for the services; source separation will not be successful

What composting technology is appropriate for you?

Large-scale, high-tech

Small-scale, low-tech

Considering: engineering and costs

Low-tech ▪▪ ⟶ **High-tech**

Increasing control of process: temperature, oxygen, mixing, reduction of emissions (odor, ammonia)

Increasing quality of product

Increasing costs (€5 to €50 per ton)

Questions

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