„Dry fermentation“; Ideal for the biological fraction?

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„ Trockenfermentation”, ideal für die biologische Fraktion?

Abstract

The Mechanical Biological Technology (MBA/MBS) is a new way of active treatment of the organic solid waste ending up in a product that is stabilised. Composting the end product is usually a problem due to heavy metal or other “unhelpful” by-products. Still there is a lot of energy in the organic waste and with an anaerobic process, at least this part can be used. Therefore many companies tried to make Biogas out of the biological fraction with more or less success. The reason for this is that the waste usually contains sand, stones, glass and other heavy, settable products. Many of the systems just can handle this. In a laid plug flow fermenter and a “dry” technology the problem of clogging can be settled. The lying plug flow fermenter works satisfactorily for the continuous fermentation of bio wastes for many years. The plug flow makes a fermentation process possible without additional liquid and can be extremely stable operated in the thermophyl temperature range. The plug flow fermenter is also used successfully in the range of the fermentation of regenerating raw materials. In addition the gas utilisation technologies like cleaning on natural gas quality and feed to the natural gas net are presented.

Keywords

Dry fermentation, plug flow, biological fraction, horizontal fermenter

1 “Dry fermentation“ ??

The term “dry fermentation“ has established over the years to document the difference to the “wet fermenter“. Of course, this term is completely absurd as there is no such thing as dry fermentation. The following list explains why there is no “dry fermentation“, because fermentation

- **always happens in the water (film)**
  - **Exoenzymes are released into the water**
  - **Macromolecules are split with these**
- **Small, dissolved molecules are absorbed into the cell**

and are metabolized there

2 Anaerobic steps of degradation and fermentation temperatures

Although it is sufficiently well-known what happens during anaerobic fermentation and how that happens, the picture by Zehnder and Guyer shows the operations in a very descriptive way:

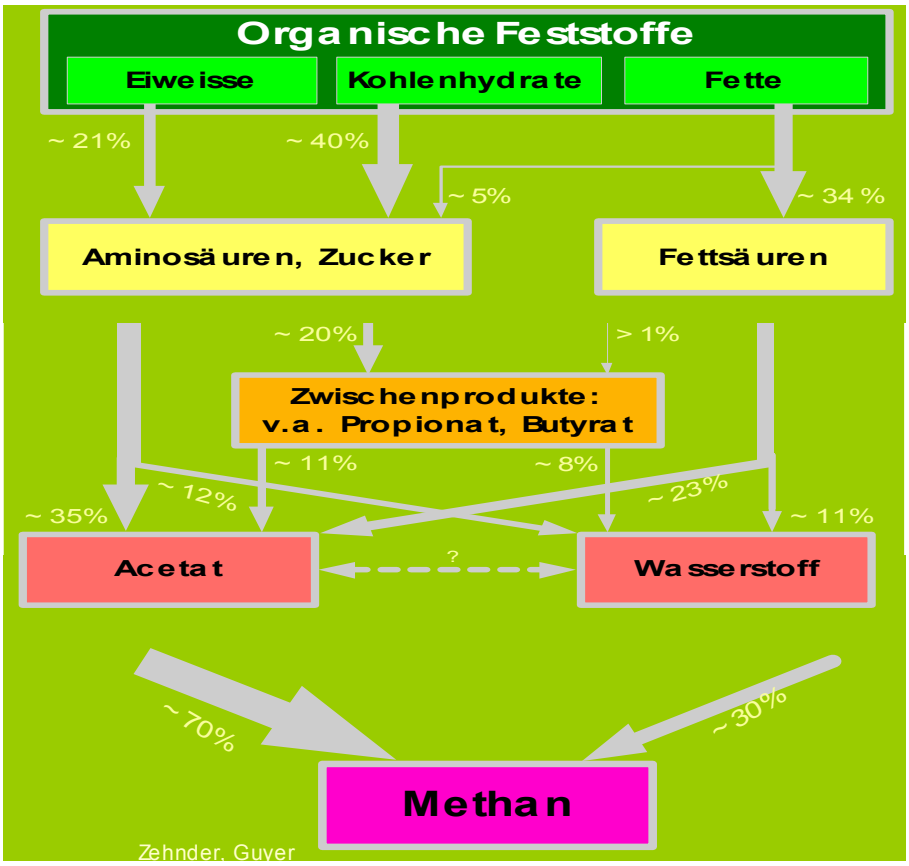


Figure 1 Operations in anaerobic fermentation

organic solid matter		
proteins	carbohydrates	fats
amino acids, sugar	fatty acids	
intermediate products: particularly propionate, butyrate		
acetate	hydrogen	
methane		

Why are different temperatures, like mesophilic or thermophilic temperaratures, used in the anaerobic technology? The mesophilic range is very well-known, especially from sewage treatment plant technology where mesophilic digesters have been used for a long time as a sludge degradation and stabilisation stage. The thermophilic range actually just became interesting when people started to anaerobically degradate organic

industrial wastewater partly with delicate content. This knowledge was then applied to the so-called “solid matter fermentation“ in the early 1990s.

The positive results/effects cannot be denied, although more energy, which of course in huge plants is recovered, has to be put into the warming-up. The main reason is that the microorganisms in the thermophlic range are much more active, and although these are small populations they are very stable and “good-natured”. Experience has shown that despite the disadvantages the sum of all advantages is prevailing.

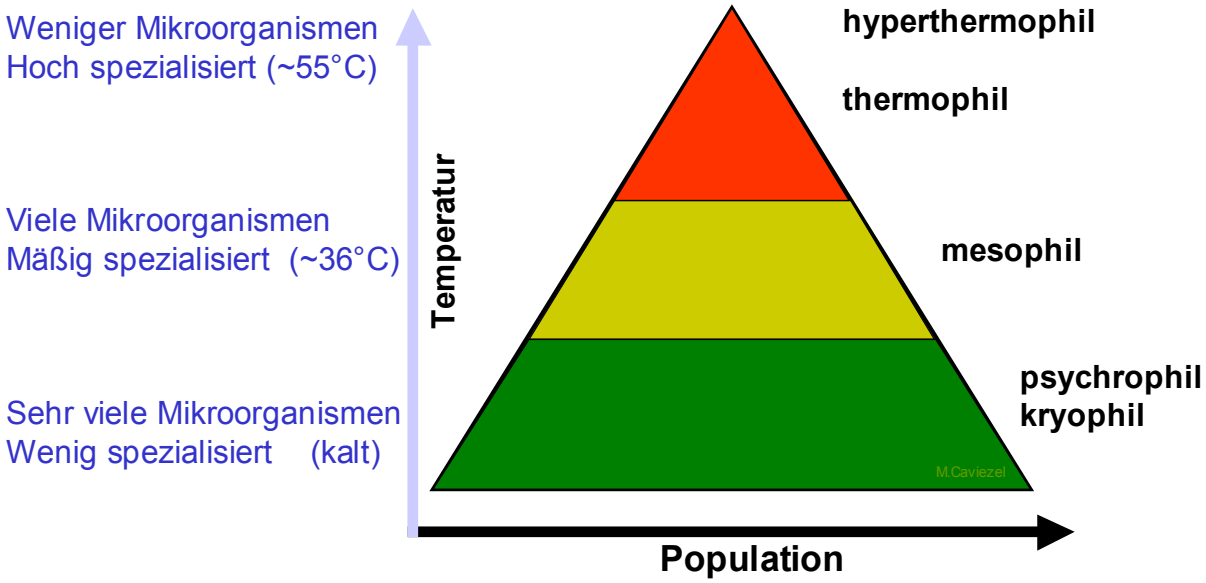
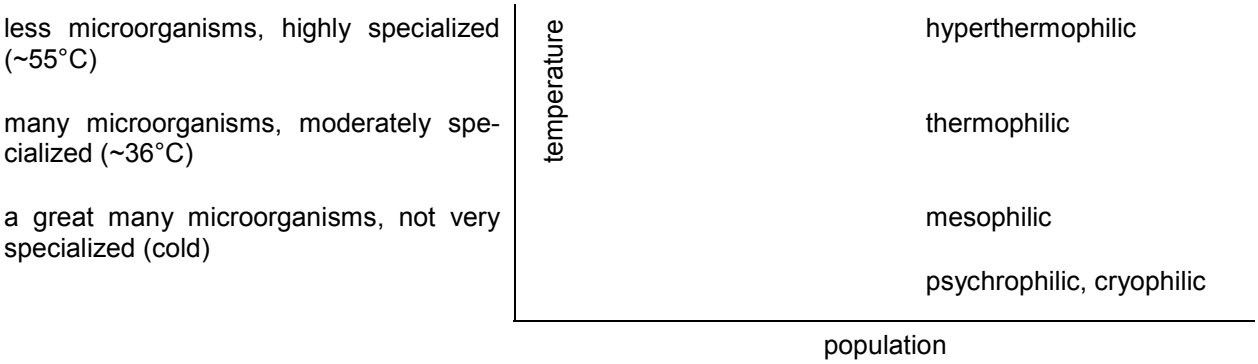


Figure 2 Specialization of the microorganisms in different temperature ranges



3 Use of “dry fermentation“ in the MBT

Thanks to this stability the thermophilic method, in connection with a lying fermenter (plug flow) and the fact that it makes sense for economical and ecological reasons not to introduce water into the process, is extraordinary suitable for the organic fraction of the MBT. Positive about that is the following:

This method, now again called “dry fermentation“, has major advantages compared to those systems in which somehow and at some point of time in the process flow large amounts of water have to be added, because otherwise the substrate cannot be moved sufficiently any more.

In the following it is tried to depict a comparison between “dry fermentation“ and “wet fermentation“.

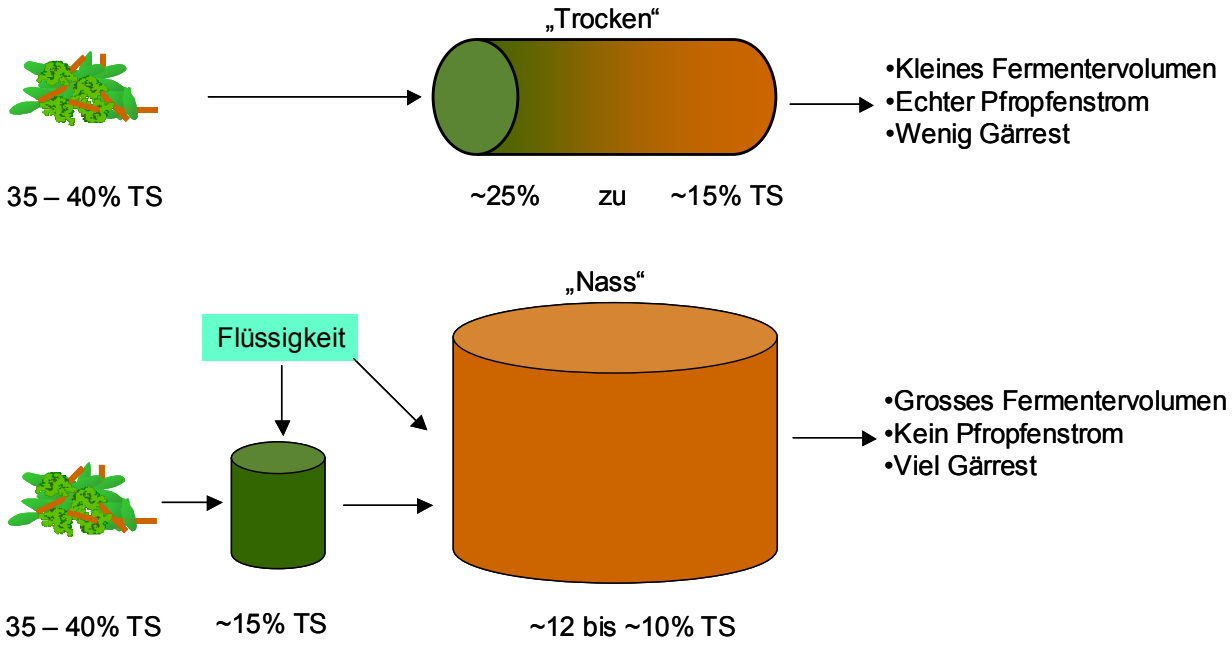


Figure 3 Comparison between dry and wet fermentation

35 – 40 % DM		“dry” ~25 to 15% DM	• small fermenter volume • real plug flow • little fermentation residue
35 – 40 % DM	Liquid 15 % DM	“wet” ~12 to ~10% DM	• large fermenter volume • no plug flow • much fermentation residue

One of the main causes for problems in “diluted“ processes or with standing fermenters is the sedimentation of the settleable solids.

The slow stirring is especially used in sludge thickeners to thicken thin sludges statically.

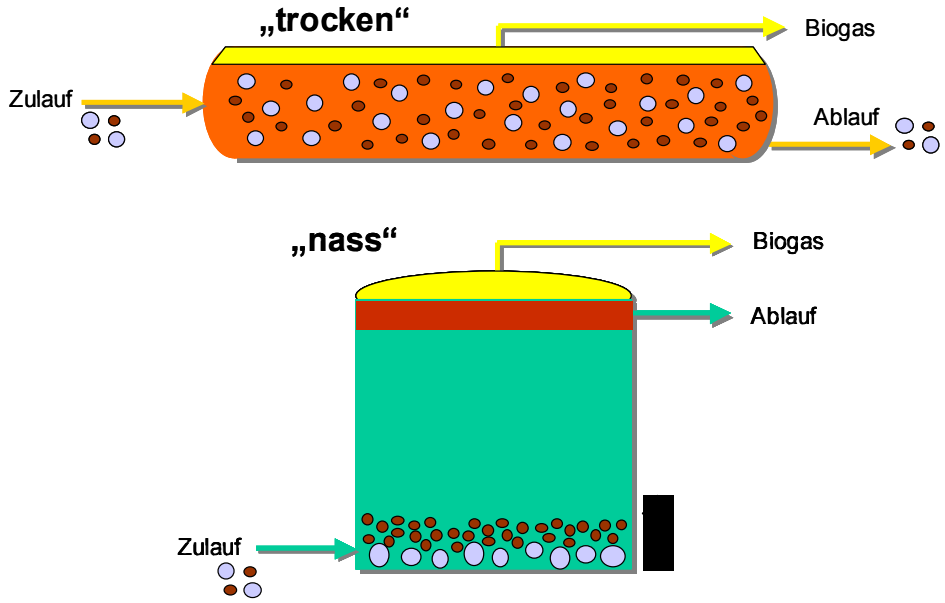


Figure 4

Explanation of the German terms contained in the figure:

- *Zulauf – inflow*
- *Trocken – dry*
- *Biogas – biogas*
- *Ablauf – outflow*
- *Nass – wet*
- *Biogas – biogas*
- *Ablauf – outflow*
- *Zulauf - inflow*

This problem is clearly not given in the plug flow fermenter as the settleable solids, which always have to be expected from a MBT, in the “thick“ sludge are also fermented in the “dry fermentation” and sediment less or not at all.

Also the stirring technique is here an essential fact for the success that the settleable solids as well as the floating sludge layer are conducted through the fermenter as a compact mass.

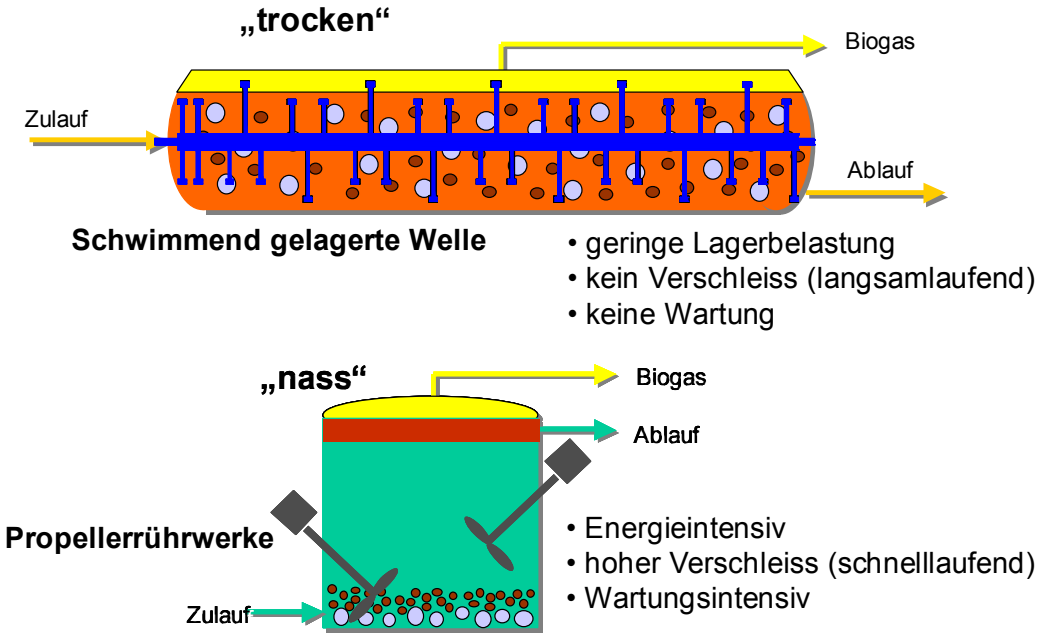


Figure 5

Explanation of the German terms contained in the figure:

- *trocken – dry*
- *Zulauf – inflow*
- *Biogas – biogas*
- *Ablauf – outflow*
- *Schwimmend gelagerte Welle – full floating shaft*
- *Geringe Lagerbelastung – little bearing load*
- *Kein Verschleiß (langsamlaufend) – no wear and tear (slow-running)*
- *Keine Wartung – no maintenance*
- *Nass – wet*
- *Biogas – biogas*
- *Ablauf – outflow*
- *Propellerrührwerke – propeller stirrers*
- *Zulauf – inflow*
- *Energieintensiv – energy-intensive*
- *Hoher Verschleiß (schnelllaufend) – high wear and tear (fast-running)*
- *Wartungsintensiv – maintenance-intensive*

The so reached plug flow ensures the retention time in the fermenter and therefore the necessary retention time for a guaranteed sanitation of the introduced substrate.

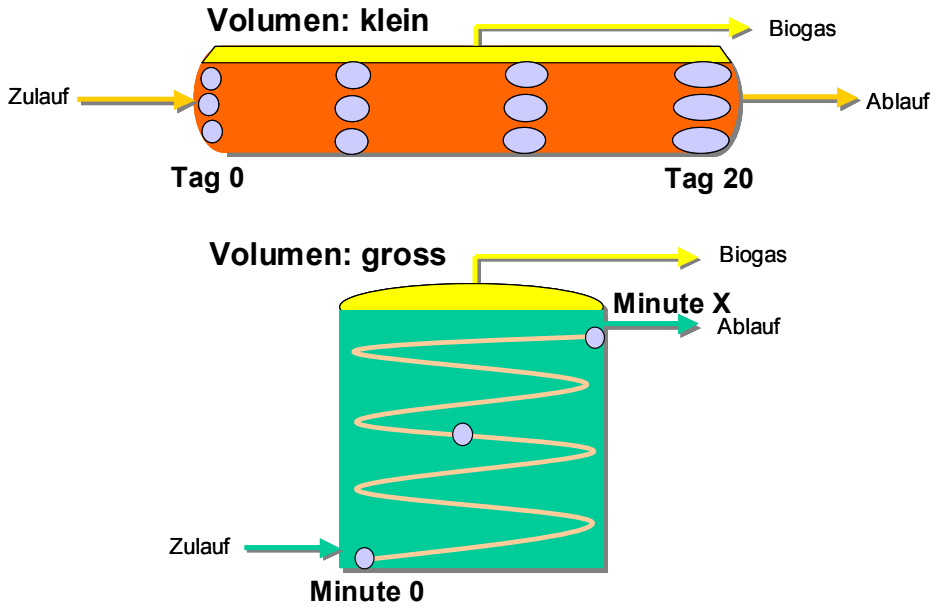


Figure 6

Explanation of the German terms contained in the figure:

- *Volumen: klein – volume: small*
- *Biogas – biogas*
- *Zulauf – inflow*
- *Ablauf – outflow*
- *Tag – day*
- *Volumen: groß – volume: large*
- *Biogas – biogas*
- *Ablauf – outflow*
- *Zulauf – inflow*

4 Comparison of the process control in MBT or for biological waste

In the following pictures the basic difference in process control between separately collected biological waste and the organic fraction of a MBT is to be pointed out. In MBT it was assumed that the final disposal still happens in a landfill. Up to today, of course several other possibilities have been discussed and partly also tested.

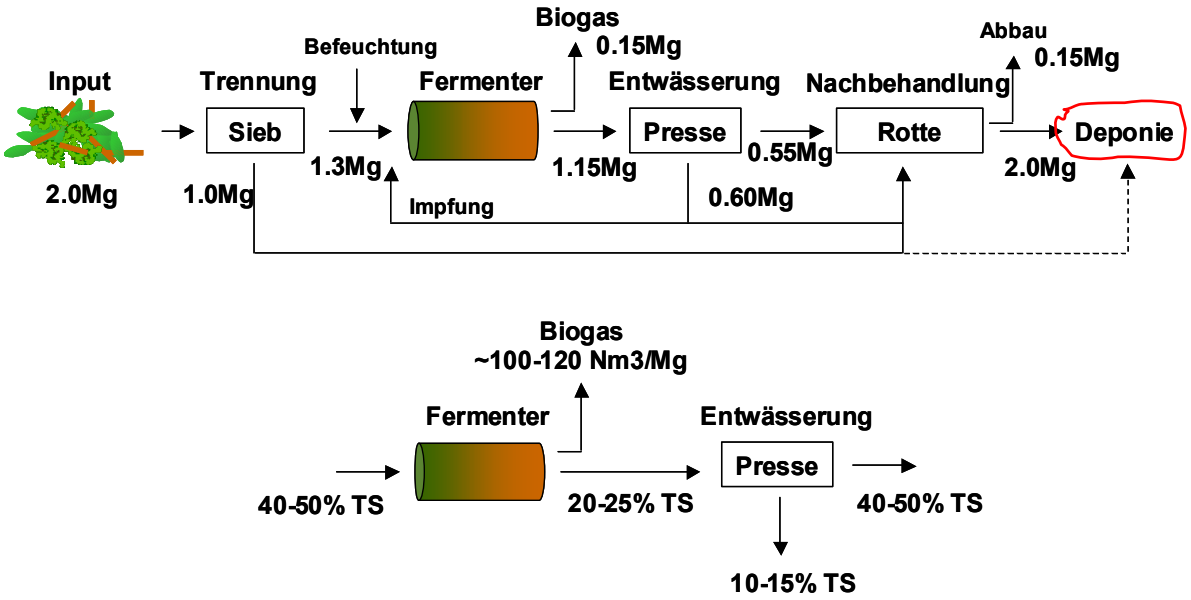


Figure 7 Concept fermentation MBT

Explanation of the German terms contained in the figure:

- *Input – input*
- *Trennung – separation*
- *Sieb – sieve*
- *Befeuchtung – moistening*
- *Fermenter – fermenter*
- *Impfung – seeding*
- *Biogas – biogas*
- *Entwässerung – dewatering*
- *Presse – press*
- *Nachbehandlung – follow-up treatment*
- *Rotte – rot*
- *Abbau – degradation*
- *Deponie – landfill*
- *TS – dry matter DM*

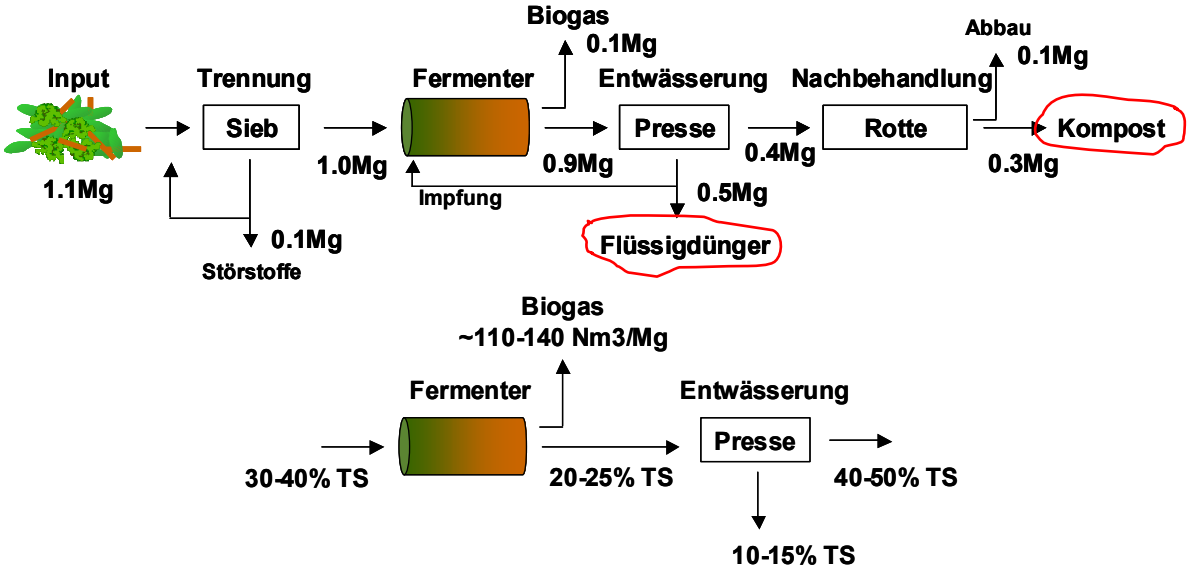


Figure 8 Concept fermentation biological waste (separately collected)

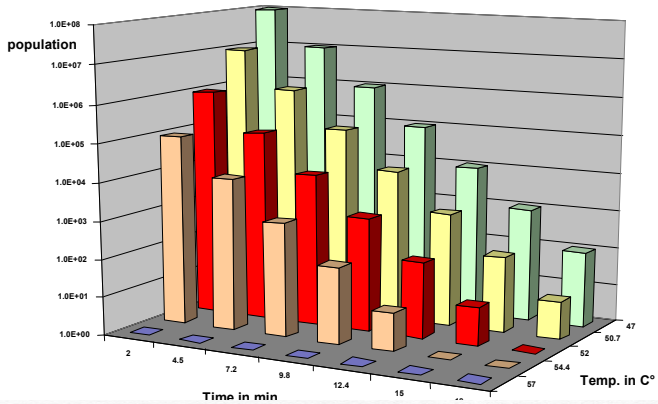
Explanation of the German terms contained in the figure:

- *Input – input*
- *Trennung – separation*
- *Sieb – sieve*
- *Störstoffe – contaminants*
- *Fermenter – fermenter*
- *Biogas – biogas*
- *Impfung – seeding*
- *Entwässerung – dewatering*
- *Presse – press*
- *Flüssigdünger – liquid fertilizer*
- *Nachbehandlung – follow-up treatment*
- *Rotte – rot*
- *Abbau – degradation*
- *Kompost – compost*
- *TS – dry matter DM*

In the fermentation of separately collected biological wastes, as it is practiced in many locations in Switzerland, it is ensured that an end product qualitity can be achieved which in all respects is safe and can be used in agriculture or in horticulture. So, the utilization (disposal) is guaranteed.

5 Hygienic aspects

As mentioned before, the thermophilic fermentation in the plug flow really is a motivation to take a closer look at the hygienically relevant aspects. In the past years several experiments were conducted to prove the stabilizing and germicidal effect of this method. It has shown that no hazardous germs or viruses survived the procedure. It was not tested for BSE pathogens, but it is to be assumed that, if such pathogens had been there, the lethal effect would have been nil. However, in all checked plants no slaughterhouse refuse or amounts of raw meat have been processed.



Bakterien	Biogasanlage 53 °C	35 °C	Lagergrube 18–21 °C	6–15 °C
	T-90 Werte		T-90 Werte	
	Stunden	*Tage*	Wochen	Wochen
Salmonella typhimurium	0,7	2,4	2,0	5,9
Salmonella dublin	0,6	2,1		
E.coli	0,4	1,8	2,0	8,8
Staphylococcus aureus	0,5	0,5	0,9	7,1
Coliforme Bakterien		3,1	2,1	9,3
Streptococcus faecalis	1,0	2,0		
Gruppe D-Streptokokken		7,1	5,7	21,4

T-90 Wert: Einwirkzeit für eine 90%-ige Reduktion der Keime

AD-Nett, 2000

Figure 9

Explanation of the German terms contained in the figure:

- *Bakterien – bacteria*
- *Biogasanlage – biogas plant*
- *Lagergrube – storage pit*
- *T-90 Werte – T-90 values*
- *Stunden – hours*
- *Tage – days*
- *Wochen – weeks*
- *Coliforme Bakterien – coliform bacteria*
- *Gruppe D-Streptokokken – group D streptococci*
- *T-90 Wert: Einwirkzeit für eine 90 %-ige Reduktion der Keime – T-90 value: exposure time for a reduction of germs by 90 %*

In the material from MBT the probability of unwanted germs is of course very high. With this method it is now possible to have at least one end product which is safe in terms of hygiene.

However, by that the product has not become better for the utilization in agriculture as there still are visible, as we like to call it, signs of civilization in the end products. Also the problem of heavy metals is not solved in the fermenter.

The “cleaner“ of course the organic fraction from MBT, the more unproblematically the following stages can be realised and the more unproblematic is a follow-up utilization.

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