The newsletter for biogas production – by Schaumann BioEnergy

BioEnergy News

# Mastering anaerobic waste digestion

Anaerobic digestion of residues and waste materials undoubtedly represents a key element of modern recycling while additionally supporting sustainable energy generation. While the objective is to utilise 100% of organic waste streams for energy creation, this aim is faced by considerable mechanical as well as biological challenges. Evaluation of data sets from 81 full-scale plants shows that only 26 % feature stable biological conditions and high capacity utilization (see fig. 1). The majority of sites encountered biological issues on a regular basis mainly due to micronutrient deficiency and/or inhibitors leading to low utilization rates and high acid loads in the digestate.

To isolate potentially problematic aspects of anaerobic waste digestion it is often expedient to classify substrates into areas associated with characteristic challenges:

- **Food waste and residual material from food production**
- **Effluents from food and starch production**
- **Municipal organic wastes from kerbside collections (organic waste bin, garden waste)**
- **Agricultural residues in combination with food waste and food production waste**

## The classic challenges of anaerobic waste digestion

### Trace element deficiency

The bacterial setup found in anaerobic digesters requires a unique set of ca. 10 trace elements. Some of these are also essential in human as well as animal nutrition, others, however, are specific to the process of methane production. As they are partly classified as heavy metals, such as nickel, cobalt, tungsten or molybdenum, they are kept from entering the human food chain. This in turn leads to depletion of these trace elements in waste streams originating from food consumption and production culminating in micronutrient deficiency and its symptoms: accumulation of volatile organic acids and process disruptions (see fig. 1). Additionally, substrate utilization decreases leading to thickening of digester content and high methane potential in the digestate. Trace element deficiency can easily be detected by analysis of digester content. It can then be balanced short-term by addition of a bespoke micronutrient mixture of the CR.TEplex-line.

In sites running on biowaste or a mixture of agricultural and industrial residues trace element supply often turns out to be sufficient during stable operation. Only after a reduction in microorganisms, e.g. by inhibitors, addition of readily bioavailable trace elements is crucial for fast recovery of the biocoenosis.

### Inhibitors

Inhibitors play a major part in anaerobic waste digestion and are responsible for a large number of process disruptions (see fig. 1). By far the most frequent inhibition occurs as a result of ammonia release from nitrogen compounds introduced by protein-rich feedstocks. Parameters influencing ammonia inhibition are ammonium concentration and digester temperature. Especially plants using elevated amounts of material from rendering facilities or poultry litter are affected. However, due to

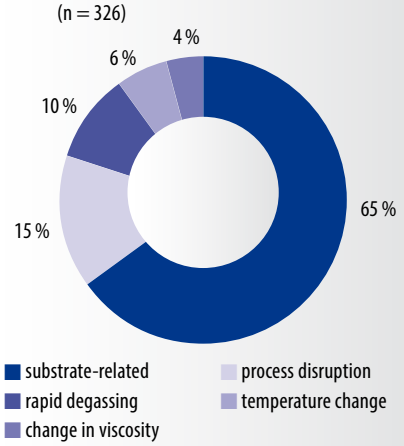
**Fig. 1:** Analysis of typical process disruptions in anaerobic waste treatment plants (n = 81)

| | Percentage [%] | Mean capacity utilization [%] | Mean organic acid concentration [mg/l] |
|---|---|---|---|
| Trace element deficiency | 48.1 | 70.7 | 3,400 |
| Inhibitors | 43.2 | 74.9 | 10,050 |
| Inhibitors + deficiency | 17.3 | 71.9 | 16,720 |
| No deficiency, no inhibitors | 25.9 | 92.6 | 1,450 |

**Fig. 2:** Inhibitors

| Inhibitor | Occurrence |
|---|---|
| Ammonia | Slaughterhouse waste, poultry litter, dairy products |
| Chromium | Leather industry |
| Copper | Pig slurry, claw baths |
| Nickel | Dry chicken litter, household biowaste |
| Zinc | Pig slurry, poultry manure, galvanized components |
| Conductivity (Na-/K-salts) | Food waste, glycerin, stillage, fish waste |
| Mycotoxins | Mouldy substrates (e.g. bakery waste, manure) |
| Antibiotics | Slurry, pharmaceutical waste, stillage |
| Chloride compounds | Cleaners/disinfectants (e.g. wastes from dairies, canteens) |
| Organic compounds | Limonene from citrus fruit, polyphenols |

**Fig. 3:** Causes for foaming in anaerobic digestion plants (n = 326)




their mostly thermophilic operation, biowaste plants also show high incidents of ammonia inhibition. As a typical effect, propionic acid accumulates in the digester and substrate utilization decreases significantly.

Even if other inhibitors occur less frequently than ammonia (see fig. 2), they can inflict equally as much damage to a digester, the most common examples being disinfectants from food processing facilities or mycotoxins from mouldy substrate batches (e.g. bakery waste).

For fighting inhibitor-induced process disruptions, Schaumann BioEnergy has its own range of products from its BC.ATOX-line.

**Fig. 4: Struvite deposits in digestate treatment unit**

## Foam

Spontaneous foam formation is a widespread problem in anaerobic waste digestion. Identifying its exact cause, however, proves difficult as it is usually the result of several coinciding factors. Apart from the presence of foam-active substances, increased degassing, surface tension and viscosity play a major part in foam formation (see fig. 3).

Combating foam can be difficult to varying degrees: for foam consisting of large bubbles, often caused by rapid degassing, the use of antifoam BC.SPcon mostly remedies the situation. Fighting fine-pored foam with high protein content or fat-based foams, however, can be considerably more challenging. Which is why Schaumann BioEnergy offers BC.SPcon AF, antifoam specifically designed to reduce foam in waste-fed plants. In some cases, though, only mechanical measures can achieve volume reduction long-term.

## Struvite and carbonate deposits

As a result of high salt and nutrient loads massive struvite and carbonate deposits can occur in percolate and digestate pipelines as well as digestate treatment units (see fig. 4). Especially food waste and percolation plants treating biowaste are affected.

Regular cleaning of pipelines mostly comes with part-load operation and significant costs. Bearing that in mind, preventive addition of crystallisation inhibitors presents an approach to minimize interruptions in operation. Schaumann BioEnergy offers the product MAPcon to reduce struvite and carbonate formation.

Fundamentally, the anaerobic digestion of organic wastes is no longer a black box and process disruptions need not be part of everyday life on waste-fed AD sites. Schaumann BioEnergy offers bespoke solutions for various process imbalances and can assist you in the biological operation of your plant. Please contact us via email or give us a call!

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