Technical and economical evaluation of digestate processing techniques

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Abstract

The current state of the art of processing techniques for livestock manures and digestates and related cost have been analysed. The techniques for solid-liquid separation of digestates are feasible without technical risks. By only separating digestates a mass reduction is not achievable and the costs for storage and application are increasing. The stabilization of the solid phase after separation by drying is desirable for an environmental friendly storage and recycling.

The processes for the treatment of the liquid phase are not yet complying with the state of the art. The most advanced are the ultrafiltration technologies that produce effluent, which can be discharged to water courses. The vacuum evaporation techniques and combined precipitation/ammonia stripping processes so far do not in every case meet limit values for discharging effluents into surface water courses.

The specific cost of the investigated processing techniques are between € 1.80 / m³ for the digestate application without processing and 15.00 €/m³ for the vacuum evaporation.

For the considered model biogas plant at a capacity of 500 kW and a throughput of 30,000 m³/a digestates economical viability is only given in rare cases. Model calculations for different system sizes, however, showed that for larger plants specific costs could be significantly reduced.

High R&D demand lies in the development of markets for organic-mineral fertilizers made from digestates

Introduction

The growing intensification of livestock production in Europe results in a regionally high accumulation of animal manures and nutrients therein. In some areas (e.g. West part of Germany) this intensification of livestock production is accompanied by a significant increase of the number of biogas plants. Both, animal manures and fermentation residues often contribute to a regional nutrient surplus, so that this organic manures cannot be reasonably used as fertilizer anymore. To use this nutrient potential effectively, it may be necessary and useful to concentrate up the nutrients in order to receive a fertilizer, which can be commercialized in regions with nutrient requirement. In this article, the current state of the art of nutrient-separation techniques for livestock manures and digestates and their processing is described as well as related costs.

Material and Methods

A compilation of the available information and data of various techniques for the processing of digestates (separation, drying, ultra filtration and reverse osmosis, vacuum evaporation, precipitation and ammonia stripping) was carried out, further related investments and costs were calculated. For cost calculations assumptions were made as following:

- Biogas plant with an electrical capacity of 500 kW,
- Feedstuff: pig slurry and mais silage
- Digestate mass/a : 30.000 t
- Digestate surplus mass: 15.000 t/a (15.000 t/a are applied without treatment on arable land close to the biogas plant).

Results

The techniques for the solid-liquid separation of digestates are feasible without technical risks. However, with this processing technique a reduction of manure quantities is not achievable and the costs for storage and application finally are increasing. Separation is therefore only meaningful if there is a local demand for the relevant products. The stabilization of the solid phase by drying is desirable for it´s storage and reuse as fertilizer / plant soil improver.

The techniques for the treatment of the liquid phase (ultra filtration, evaporation, ammonia stripping) are not yet complying with the state of the art. All of these techniques need to be well adjusted to the physical and chemical properties of the liquid phase of the digestate. The most advanced technique represent the ultra filtration technologies, which mostly produce a well purified effluent, that can be discharged to water courses. The vacuum evaporation techniques and combined precipitation/ammonia stripping processes so far not always meet legal limit values for the discharging to surface water courses.

The specific costs of the investigated processing techniques are shown in figure 1. As a reference system the costs for the storage (6 month) and the application of the digestates on arable land at a distance to the biogas plant of 4 km (without treatment) were calculated. Total costs for the reference make around 6,80 €/m^3, whereof around 4,40 €/m^3 need to be spent for transportation and spreading. Taking into account the nutrient value of the digestates, the net costs make finally 1,83 €/m^3.

Separating of the digestates results in extra costs for storage and application of the solid fraction, therefore costs and net costs are somewhat higher (7,00 €/m^3 and 2,59 €/m^3). Drying with a belt dryer reduces the total mass to be managed marginally, but increases the costs considerably up to 11,50 €/m^3 of the produced digestate. Taking into account nutrient value and a bonus, which is paid for the use of the heat produced by power-heat-coupling according to the German Renewable Source Legislation, the net costs amount at 5,00 €/m^3.

The processing of the liquid fraction of the digestate by an ultra filtration unit followed by an reverse osmosis unit results in high fix costs of almost 4 €/m^3, which are primarily caused by the high investment for the technical equipment. Adding up additionally the costs for energy and consumables (acids etc.), storage and application to land the costs amount to a total of 12 €/m^3, which results in net costs of 7,50 €/m^3. Similar total and net costs were also found for the processing techniques vacuum evaporation and precipitation/ammonia stripping.

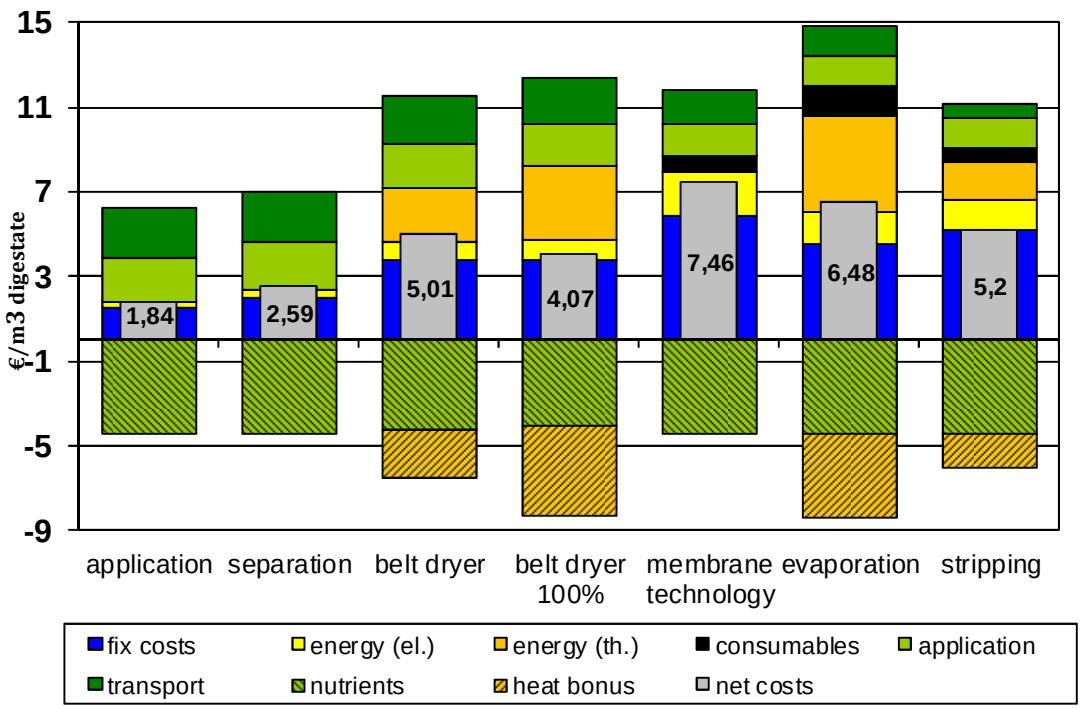

Figure 1: Specific total and net costs (€/m^3) for the treatment/processing of digestates [1], [2]

Conclusions

Great progress has been achieved in the performance and the technical reliability of digestate processing techniques over recent years. Nevertheless for all of the liquid fraction treatment technologies high development potential is seen in order to improve reliability, to reduce energy consumption as well as abrasive wear.

The cost analysis indicates, that even at higher fertilizer prices, the conventional recycling system with storage tanks and mobile spreaders will stay the most favourable option. If nutrient surplus is needed to be managed, processing of manures will increasingly become an option in intensive agricultural regions. However, high R&D demand lies in the development of markets for organic-mineral fertilizes made from digestates.

References

[1] Döhler, H.; Wulf, S. (2009): Aktueller Stand bei der Gärrestaufbereitung; Gülzower Fachgespräche Band 30, S. 15-28

[2] Döhler, H.; Wulf, S. (2011): Technical digestate treatment -advantages, limitations, costs; Biogas Europe Conference, 25th-26th October 2011, Nantes, France