Managing phosphorus cycling in agriculture

Pretreatment of manure

Biogas plant with a feed bunker for dry coproducts

Introduction & Method

Anaerobic digestion of cattle and pig manure produces a relatively low amount of biogas per cubic meter. On one hand this is caused by a high amount of water (>90%) in the manure and on the other hand by the partial utilization of the energy potential in the organic matter. A short survey has been done into the effect of several pretreatment technologies on the biogas production of manure. This survey gives a global overview of the prospects of different methods for the pretreatment of manure to increase the biogas production.

Results

The biogas production of cattle and pig manure is around 20 to 30 m^3 biogas per ton. If by pretreatment the biogas production would rise with 50% then the total biogas production would only rise with 10 to 15 m^3 biogas per ton of manure. In a CHP-installation this would lead to an extra revenue of roughly € 3,20 to € 4,80 per ton of slurry. Therefore the cost of the pretreatment needs to be low in order to be economical feasible.
A scenario where the thick fraction of manure will be pretreated separately on a farm is expected not to be economical feasible under the current circumstances due the small amount of the thick fraction, extra costs and labour requirements. Possible side-effects of pretreatment technologies can have a large influence on the prospects of certain pretreatment technologies. But at the moment there is insufficient knowledge about these side-effects. As far as is known there are no practical experiences with pretreatment technologies for slurry, but only research

Conclusions

On the basis of this study the following technologies could be promising for anaerobic digestion of manure:

1. thermal pretreatment if a cheap heat source is available,
2. aerobic pretreatment and
3. hydrolysis of manure.

The other technologies mentioned in the study seem to offer an insufficient prospect for anaerobic digestion for the time being due complexity, cost and/or expected effect on the biogas production. If only the thick fraction will be pretreated then this should be done in a central or regional co-digestion plant due to scale sizes. Therefore promising technologies for the pretreatment of the thick fraction need to be assessed in conjunction with the pretreatment of coproducts.

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Drying of manure

Introduction & Method

Almost all biogas plants on Dutch farms are co-digestion plants. Under current Dutch law this leads to an increase in 'animal' manure production since the minerals nitrogen (N) and phosphate (P_2O_5) in the digestate, which originate from the co-products, fall under the application standards for animal manure. But co-digestion also offers opportunities for manure treatment since a lot of biogas plants have a substantial heat surplus. An option could be to use this heat to dry the digestate to a dry product which can be used in sectors outside agriculture, exported or burned for energy production. This would lead to a decrease in the supply of manure in Dutch agriculture. Therefore a short survey has been done into the prospect of drying of digestate from biogas plants. This survey gives a global overview of the (im)possibilities of drying of manure(fractions) at different scale sizes of (co)digestion.

Results

On the basis of the heat transfer method to the material the following classification in dryers can be made: convection dryers, conduction dryers and radiation dryers. In general there are several modifications within each group of dryers. A further subdivision can be made into batch and continuous dryers. Conduction dryers are more complex and therefore in general more expensive. However the volume of off gasses is small which make the treatment of these off gasses easier. Furthermore its easier to recover the energy from the off gasses. Therefore conduction dryers offer the best perspective for use at a biogas plant.

Picture: dry manure and a briquette made out of dry manure

Conclusions

An industrial dryer for small scale manure digestion plants is under the current circumstances not interesting due e.g. the high investment costs, complexity of the drying process and possible alternatives for use of surplus heat in stables and the farmhouse. For co-digestion plants of substantial size a drying installation can offer an opportunity to reduce the cost for disposal of the digestate. The treatment of the off gasses is considered to be the biggest bottleneck for drying of manure and digestate. In the treatment of off gasses from the dryer the following components are of importance: dust particles, water vapour, ammonia, odour and inert gas.

Factsheets Wageningen innovation studies on manure processing:

No. 23 Tentative results from innovation studies in a nutshell
No. 24 Phosphate recovery from animal manures
No. 25 Reduction of Dutch agricultural phosphorous load through bio-refinery
No. 26 Pretreatment of manure
No. 27 Biochars from digested fattening pig slurry
No. 28 Market survey into reduction of phosphorous in pig feed
No. 29 Feeding management to reduce phosphate in animal husbandry
No. 30 Slurry separation justifies differentiation of manure application thresholds

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