EBA
European Biogas Association

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EBA opinion on the digestate drying at biogas plants

In several European countries effective use of the heat generated during processing of biogas to power is obliged by law and/or supported by public funds. In this context, EBA would like to draw attention to possible unnecessary wasting of heat in the digestate (fermentation residue from the anaerobic digestion process) drying process, which could be considered as economically justifiable heat consumption eligible for funds.

Drying of digestate is a relatively old technology and was first introduced (and tested) in 1980's. The technology was supposed to transport concentrated mineral content of digestate from areas with intensive agricultural production to areas with shortages of organic and mineral supply in agricultural land. However, this concept was shortly rejected because of the dramatic reduction of nitrogen content during drying, which resulted in the degradation of fertilising effect of the digestate.

Nowadays, we observe an effort to reintroduce the digestate treatment technology in several countries in Europe. This phenomenon is related to an artificial promotion or obligation to use heat produced at biogas plants. The technical, economic and environmental scarcities of digestate drying are presented below.

Technical, economic and environmental aspects

The promotion of biogas is based on the environmental benefits that this renewable gas brings in comparison to fossil fuels. Such benefits can be achieved under condition that the raw materials are produced in a sustainable and responsible way. Complete recycling of residual organic carbon and minerals (nitrogen, phosphore, and potassium - NPK) and their disposal on the productive farmland is a generally acknowledged condition of this concept.

Due to the highly reductive environment during the biogas formation, digestate contains almost all of the nitrogen in the ammonium form (NH_4^+), which is released into the air during the drying process. If effective scrubbing of the exhaust air with simultaneous production of e.g. ammonium sulphate is not provided, entire nitrogen content in digestate is practically eliminated after the drying process.

Significantly higher damages can be caused by using dried digestate as a fuel in boilers. The combustion of digestate leads to an irreversible disruption of the carbon cycle and NPK nutrients chain, so these must be secured from other (fossil) sources. In this context we want to draw attention to a very limited world reserves of apatite ($Ca_3(PO_4)_2$), which is basically the only source of phosphorus in modern industrial fertilisers worldwide. Thus, consequences of firing digestate can be devastating and break the recycling chain of organic carbon, which is needed to maintain the humus content for the production of agricultural crops. The complete recycling of the organic carbon and essential nutrients (NPK) is a crucial condition for the sustainability of energy from biogas.

The technical and economic shortages of digestate drying are due to the fact that the natural nutrients recirculation is in this process replaced by artificial (industrial) fertilisers. The production of NPK fertilisers is a relatively power-demanding branch of the chemical industry. The amount of energy that will be spent to produce an equivalent amount of fertiliser (when the attempt to quantify the costs that come from the disruption of the organic carbon cycle is ignored) needs to be taken into account when considering the societal benefits of the support of usage digestate as a fuel.

The following table shows the content of NPK nutrients in the digestate generated solely from purposefully grown biomass - corn silage (Table 1). These values can be considered as minimal. Treatment of manure and other agricultural waste would increase the content of NPK nutrients. Absolute values are calculated for a biogas plant with electrical capacity of 1,000 kW.

Table 1. Relative and absolute content of NPK nutrients in digestate

Entry data	Concentration (%)	Absolute production (t/a)
Dry matter	7.3	943
Dipotassium oxide (K_2O)	0.78	101
Diphosphorus pentaoxide (P_2O_5)	0.18	23
Total nitrogen (N)	0.63	81

The table below shows the energy consumption for the production of indicated quantity of NPK nutrients, according to International Fertiliser Industry Association (Table 2).

Table 2. The energy consumption needed for the production of basic NPK fertilisers (the whole production process) [International Fertiliser Industry Association]

Calculating equivalent of a nutrient	Fertiliser type	Energy consumption per nut. eq. (GJ/t)
dipotassium oxide (K_2O)	KCl	5.0
diphosphorus pentaoxide (P_2O_5)	triple superphosphate	5.3
total nitrogen (N)	DAM 390	43.8

The following paragraphs present energy balances, comparing:

- energy yield of 1 tonne of fuel produced from digestate,
- to energy demand used for producing an equivalent of artificial fertilisers required to balance the nutrients lost in digestate.

It is possible to get 943 tons of dry matter which is equivalent to 1,110 tons of pelleted fuel with the dry matter content of 85% and a calorific value of 3 MWh/t (10.8 GJ/t) out of the total production of digestate at the biogas plant mentioned above (1,000 kW). The total annual production of dried digestate has therefore a usable heating value of 11,992 GJ.

The last table shows the energy consumption of the production process as an amount equivalent to industrial fertilisers, which would be needed to substitute the fertilising effect of combusted digestate.

Table 3. Consumption of energy needed for the production of basic NPK fertilisers equivalent to the production of digestate at a biogas plant with capacity of 1,000kW

Calculating equivalent of a nutrient	Production at a biogas plant 1000 kW (t/yr)	Consumption of energy per nut. eq. (GJ)
Dipotassium oxide (K_2O)	101	503
Diphosphorus pentaoxide (P_2O_5)	23	120
Total nitrogen (N)	81	3,537
TOTAL		4,160

It can be concluded that the enforced production of industrial fertilisers, replacing wasted fertilising effect of the digestate, **consumes about 35% of the total energy of the calorific value of digestate produced**. This value is the minimum value achieved by processing only purposefully grown biomass in the concept of agricultural biogas plants. In case of using waste materials and animal by-products, which contain significantly more nitrogen compounds, this value would raise rapidly. This growth disproportion is caused by approximately ten times higher energy-demanding production of nitrogenous fertilisers (40-50 GJ/t), compared to other basic nutrients NPK fertilising complex. **In case of growth of the total nitrogen content in the digestate to 1%, the production of fertilisers would already consume 50% of energy from total calorific value of the fuel from the digestate.**

Conclusion

For all the above mentioned reasons, we consider, from the environmental and the energetic (and thus economic) standpoint, the **digestate drying a very questionable technological method**. The idea of public, societal support of this technology brings a big question mark over the real intention of the introduction of the support.

Implementing support schemes for **digestate drying** would in effect constitute a **serious threat to the concept of sustainable production of energy from biogas** and very likely discredit the entire field of production and utilization of biogas in the eyes of the general public.

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About European Biogas Association (EBA)

European Biogas Association asbl (EBA) was founded 3 February 2009 as a Belgium non-profit organization aiming at promoting sustainable biogas production and use in Europe. EBA's membership comprises currently national biogas associations, institutes and companies from 24 countries all across Europe. EBA unites a large number of the most experienced biogas experts in Europe and has highly experienced and skilled staff providing policy advice, know-how and information to promote beneficial legislation and framework conditions in the field of biogas. For further information please visit: www.european-biogas.eu