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Biogas-Plants

Sanitation Requirements for Substrates, Technology and Costs

Various legal regulations on European and national levels require sanitising treatment for digested substrates. During the project planning phase the responsible authorising agency should be contacted early to coordinate sanitation requirements and calculate alternatives according to economic aspects.

With the German animal by-product law coming into force at the end of January 2004, serving the implementation of the EU-Directive No 1774/2002 of October 3, 2002 (on animal by-products, not intended for human consumption), regulations for operating biogas-plants and the agricultural use of their effluent were fundamentally new structured. In order to avoid parallel rules on the national and the EU-level, the national law on the disposal of animal bodies (TierKGB 2001) was taken out of force, other regulations were amended. The national

biowaste ordinance (BioAbfV 1998) e.g., is now restricted to biowastes of herbal origin. National and European fertiliser-legislation are still effectual. The above-mentioned legislation determine the kind of sanitation-equipment necessary for a biogas-plant.

Present legislation for different model-plants

Table 1 shows necessary sanitation-requirements according to the origin of the digested

Table 1: Requirements for sanitation according to legal regimentation, origin of substrates and utilisation of biogas-plant effluents

Model-plant	Substrate	relevant legislation	utilisation of the effluent	operation-mode of the plant	kind of sanitation
1a	AM ¹ , RWRM ²	EG 1774/2002 ⁵ DüngeV ⁶	on proper fields	mesophilic	none
1b	AM ¹ , waste from flour mills ³ (purchased)	EG-V 1774/2002 ⁵ , BioAbfV, DüngeV ⁶	on proper fields	a) thermophilic ⁹ b) mesophilic	a) none b) pasteurisation of the biowaste or composting after fermentation
1c	AM ¹ , RWRM ² , waste from flour mills ³ (purchased)	BioAbfV, DüngemittelV, EG- 1774/2002 ⁵ , DüngeV ⁶	put in circulation (commonly run plant, 3 farmers)	a) thermophilic ⁹ b) mesophilic	a)none b) pasteurisation of the biowaste or composting after fermentation ¹⁰
2a	AM ¹	DüngemittelV ⁶ , DüngeV EG-V 1774/2002 ⁵	put in circulation (commonly run plant, many farmers)	thermophilic ⁹ or mesophilic	none ¹⁰
2b	AM ^{1,4} , RWRM ² fat separator residue of animal origin	EG-1774/2002 ⁵ , Tierseuchenrecht ⁷ (ViehVerkV), DüngeV ⁶	on proper fields	thermophilic ⁹ or mesophilic	pasteurisation of the animal by-product (70°C; fat separator residue)
2c	AM ^{1,4} , RWRM ² , biowaste of animal origin (no cat. 1-mater.)	EG- 1774/2002 ⁵ , DüngeV, Tierseuchenrecht ⁸ (ViehVerkV)	on proper fields	thermophilic ⁹ or mesophilic	pasteurisation of the animal by-product (70°C; biowaste of animal origin)
2d	AM ¹ , food-waste of animal origin (category 3-material), bio-waste of herbal origin according to BioAbfV	EG- 1774/2002, BioAbfV, DüngemittelV, DüngeV ⁶	put in circulation	a) thermophilic ⁹ b) mesophilic	a) pasteurisation of category 3-material (70°C); b) pasteurisation of category 3-material 70°C and pasteurisation of the biowaste (70°C) or composting after fermentation

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Keywords

Biogas-plants, legal requirements, sanitation, costs

Literature

[1] KTBL-Agru „Hygienepflichtsystem für Vergärungsanlagen“: Vorschlag zur Überarbeitung von Anhang 2 BioAbfV, erstellt im Auftrag des BMU (UFOPLAN 903 33 307) (www.ktbl.de)

1. animal manure like liquid manure, urine , dung
2. renewable vegetable raw materials
3. biowaste of herbal origin, according to biowaste ordinance
4. farm with cloven-hoofed animals
5. licensed according to EU-directive Nr. 1774/2002 article 15 (including HACCP)
6. Fertilising ordinance
7. livestock transport ordinance
8. Fertiliser ordinance
9. thermophilic according to the definition of the biowaste ordinance
10. „full-stream pasteurisation“ legally not required, but recommended according to pest-control purposes

substrates and the utilisation of the effluents. Model-plants No. 1a to No. 1c digest besides animal manure (AM) exclusively renewable vegetable raw materials (RWRM) and/or biowaste of herbal origin. Model-biogas-plant 1c is run cooperatively. Plants 2a to 2d treat, besides animal manure, wastes or products of animal origin.

Because of processing animal manure, biogas-plant 1a is subject to the EU-Directive 1774/2002 and the national fertilising ordinance (DüngeV). EU-regulations don't ask for sanitation-requirements in case the manure application is restricted to the fields of the farm, where the biogas-plant is run, so model 1a can be operated mesophilically. In case waste from flour-mills is co-digested (1b), additionally the German biowaste-ordinance has to be applied (pasteurisation at 70°C before or after the process). Since plant 1a is run cooperatively, the national fertiliser ordinance (DüMV) should be taken into account. Although sanitising the manure is not legally fixed, according to pest-control-purposes this is recommended in this case.

It is recommended, too, for the solely manure-digesting, that the cooperatively run plant 2a, in order to minimise the risk of transmitting pathogens to humans and animals. Because of the treatment of fat separator residues and/or kitchen biowaste in plants 2b and 2c, according to the national livestock transport ordinance (ViehVerkV 2004), pasteurisation of the relating substrates is necessary. In case a biogas-plant is run on a farm with cloven-hoofed animals, substrates must be pasteurised (70°C, 1h) even before entering the farm. In biogas-plant 2d biowaste and food-waste of animal origin (category 3-material according to EU 1774/2002) are treated besides manure. When the plant is run thermophilically at 55°C, the category-3-material must be pasteurised additionally.

Technical description of the pasteurisation-unit

Thermophilic operation: this operation-mode is only accepted by the national rules, not according to the EU-directive 1774/2002. The biowaste-ordinance stipulates 55°C operating temperature, 24 h minimum residual time and 20 d hydraulic residual time in the reactor.

- In stirrer tank fermenters, substrates are quickly evenly distributed and can often be detected in a few hours time in the effluent. If 24 hours minimum residual time has to be guaranteed, interrupted loading and unloading in a 24 hour-rhythm is necessary. This operating-mode is viewed critically, since it is a highly sensitive fermentation process.

- In cork stream fermenters, a different performance of solids and fluids can be observed: while solids move like a cork from the loading- to the unloading-end, fluids disperse in a few hours within the whole fermenter. In this case, too, it can not be excluded, that substrate leaves the fermenter in less than 24 h.

The Association of Technology and Structures (KTBL) proposed for the planned amendment of the biowaste ordinance to replace the fixed 24 hours-period by a biogas-plant-specific fixation of the minimal residual time. The determined period fixes the duration of the process test, which checks the sanitation-effect of a plant.

Pasteurising: Before the fermentation, a pasteurisation can be run „part-stream“ (only the co-substrates legally bound are treated) or „full-stream“ (all substrates are treated). When pasteurising after the fermentation, always the whole substrate is treated.

For biowastes, which can not be pumped easily (biowaste from households), an upstream-pasteurisation is difficult to be run, if not the water-content, e.g. with liquid manure, is increased. Downstream-pasteurisation-units run far more reliably.

Generally, for smaller units, low-cost inside heat-exchangers are used, whereby firmly bound deposits and incrustations are accepted. In order to obtain an acceptable heat transmission, the pasteurisation tank should be supplied with an agitator. Up from 25 m³/d of material to be pasteurised, systems with outside heat-exchangers outside become more economical.

Whilst part-stream treatments often work with one tank in the batch-mode (heating-, pasteurisation-, cooling-phase following each other), full-stream treatments can ideally be run with two or three tanks. These tanks can be filled and emptied at different times, which enables a continuous operation (filling of the fermenter, microbiology of the process) of the biogas-plant and the recovery of the bulk of the heat from the pasteurisation-process.

Costs and economic efficiency of the utilisation of substrates which need heat-treatment

Costs of a part-stream pasteurisation and the effects on the economic efficiency of operating a plant are calculated exemplarily for model 1 (approximately 2,500 tons/a treatment capacity).

The following co-substrates are compared with each other: rye (renewable vegetable raw material, 250 tons/a) and waste from flour-mills (biowaste to be sanitised, 300 tons/a) with same absolute gas production.

For the co-fermentation of biowaste, a pasteurisation-unit, which includes beside the tank pipes, valves, gate valves, measuring and control technology, has to be installed as well an additional tank to mix the waste from the flour-mill with some liquid. Investment needs are calculated with 25,000 € plus 10 % related costs. Costs are calculated to 3,548 €/a (technology) plus 2,737 €/a for additional work. The heat produced by the combined heat and power plant is sufficient for the pasteurising the substrate. As the price for the biowaste (50 €/t flour-mill waste) is 7,670 €/a lower than for rye (90.68 €/t), the total costs of treating biowaste is, despite additional expenses, in this case lower than of treating renewable vegetable raw material. Nevertheless, according to the remuneration-rules of the renewable energy law (EEG), a bonus of 6 €Ct per kWh will not be paid for the co-substrates animal manure and/or renewable vegetable raw material, if biowaste is co-digested in a biogas-plant, so there will be a deficit in receipts for electric energy of around 35 000 €/a.

Conclusion

Depending on the substrates of biogas-plant, sanitation-requirements are very different. A thermophilic (55°C) operation, which will sanitise the whole substrate, is not sufficient according to EU-Directive No 1774/2002. For co-fermentation plants, a full-stream pasteurisation is, presently, not stipulated neither according to national nor to European law. Due to pest-control-reasons, for cooperatively run plants such a treatment can be reasonable. A exemplary calculation shows nevertheless, that even part-stream pasteurisation can not be economical because of the remuneration-rules of the EEG. Sanitation-requirements therefore should be checked in time with the responsible authorising agency.