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The ECOWEL® Farm-System

A process-integrated System for Processing Liquid Manure with an Integrated Air Scrubber System used for Pig Fattening

The Ecowel® farm system can process liquid manure in combination with an integrated air scrubber system and makes it technically possible to reduce both the volume of liquid manure and the ammonia emissions from the stable. The purpose of this process is to produce a transportworthy solid substance and a liquid with low nutrient content, with which a sewage bed reactor can be operated to purify the waste air. During a one year research period, both the efficiency of the system, in terms of emission reductions, as well as nutrient separation were investigated and evaluated.

Proof of scarce agricultural areas for correct procedures in accordance with the dung ordinance results make it difficult in regions with intensive animal husbandry to obtain authorisation for stocking up installations for breeding pigs and for fattened pigs [1]. Extension of installations is frequently only possible when technological measures are implemented which result in a reduction of the surplus of nutrients and of ammonia emissions. The ECOWEL® farm system from the company WEDA, Lutten, provides such measures. This system has a means of processing liquid manure with integrated air scrubber, which can be also connected to existing installations with decentralised waste air guide ways. The system is designed to produce solid transportworthy material and a stabilised, low-nutrient liquid fraction with which the air scrubber can be operated.

System, material and methods

A pilot installation of the ECOWEL® farm system was integrated in a pig house with 2000 fattening places. The system for processing liquid manure is constructed in a modular way and can be divided into the individual modules separating, biological processing in the sequential batch reactor (SBR), drying and filtering (*Fig. 1*).

The separation of the raw liquid manure is implemented by a screw press (daily throughput 4 m^3). The separated solid fraction is dried on a three-stage drying belt. For this purpose, warm air from the stable and from the central ventilation shaft is used, which after drying is fed back to the air shaft.

The separated liquid fraction is fed in batches to the SBR, in which the biological processing takes place using nitrification and de-nitrification processes, whereby the nitrogen content of the liquid fraction can be substantially reduced. The biologically prepared liquid fraction then reaches the module for chemical decomposition with pressure filtration (Towerfilter®, from the company WEDA). For chemical decomposition, the prepared liquid fraction is mixed with iron-(III)-sulphate and a cationic polymer. As a result of this decomposition, the solid materials and phosphor compounds are precipitated and then filtered off in the pressure filter. The filtrate obtained in this way, low in

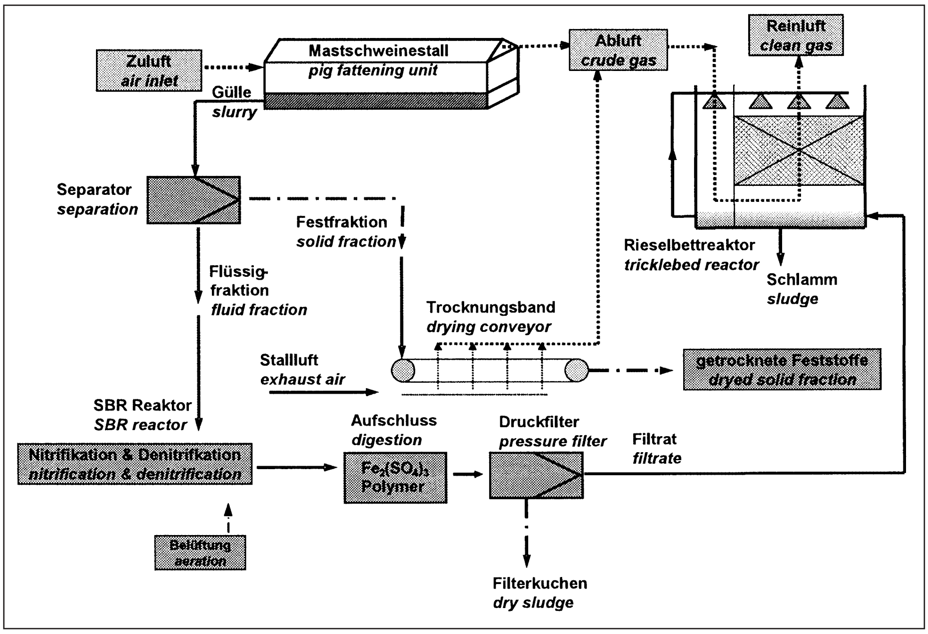

Fig.1: Process flow of the Ecowel® Farm-System (Fa. WEDA)

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Keywords

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Literature

Literature references can be called up under LT 07303 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

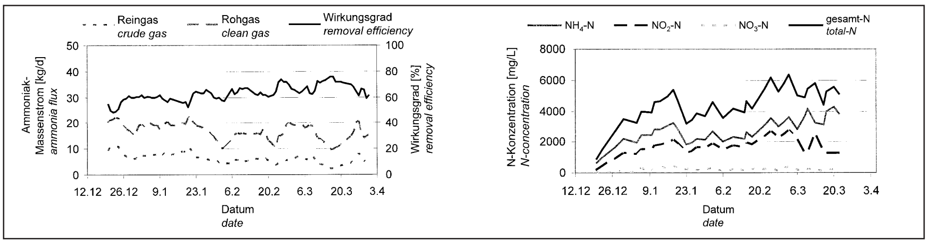

Fig. 2: Left: Ammonia mass flow and removal efficiency of the 2nd biological experiment with ground water. Right: Developing of ammonia-, nitrite- and nitrate concentration as well as total N-concentration during the 2nd biological experiment with ground water

nutrient and almost free from solid material, can be used as a washing liquid for purifying the waste air.

The sewage bed reactor used for air scrubbing is operated in a down-stream process and has a filling body volume of 65m³ and a washing liquid receiver of 58m³. The sprinkling density can be varied between 45 and 100 m³/h. The maximum filter volume load is 3080 m³/(h•m³).

The sewage bed reactor was operated for an experimental period of up to four weeks with pure ground water. During this time, three experiments each lasting three months were carried out. The daily elutriatation rate was 0.27 m³ in all experiments. At the end of an experiment, the washing liquid receiver was emptied and refilled at the start of a new experiment. The breakdown of the nitrogen content of the washing liquid was carried out biologically using nitrification and de-nitrification processes. In the four remaining weeks, the sewage bed reactor was operated with a filtrate/groundwater mixture in a ratio of 2:1. In this case, as well, the daily elutriation rate was 0.27 m³ and the nitrogen breakdown was carried out in nitrification and denitrification processes.

In order to monitor the efficiency of the sewage bed reactor with regard to ammonia elimination, the gas concentrations (NH_3, N_2O, CH_4, CO_2) of the non-purified and purified stable air (raw and clean gas) were recorded by a photo-acoustic measurement system from the company Innova, Denmark. In addition, the ammonium, nitrite and nitrate concentrations were determined at regular intervals in the washing liquid.

Results and discussions

Processing of liquid manure

The liquid manure fed in was separated into a 86 %v liquid fraction and a 14 %v solid fraction. Following separation, there were 29 %v of the phosphor content and 22 %v of the nitrogen content of the raw liquid manure in the separated solid fraction. The separated solid fraction had, on average, a dry mass content of 36 %. By drying with the waste air from the stable, the dry mass content was increased to 55 % (winter) and 87 % (summer), respectively. The dried solid material was almost free of odour and had almost no trace of an ammonia-like odour.

By means of the biological processing in the SBR, the nitrogen content (ammonium, nitrite and nitrate) of the liquid fraction could be reduced by 66 %. The chemical decomposition with subsequent pressure filtration additionally reduced the nitrogen content by a further 66 %. In total, there was, as a result of the biological processing and subsequent chemical decomposition with pressure filtration, a reduction in the nitrogen load by 88 %, referred to the nitrogen content in the separated liquid fraction. Compared to the biologically prepared liquid fraction, the filtrate obtained had a phosphor content that was reduced by 54 % and a carbon content which was reduced by 95 %. *Table 1* gives an overview of the nutrient content of the individual substrates of the liquid manure preparation.

Air scrubber system

In the series of experiments in which the sewage bed reactor was operated with pure groundwater, an average efficiency of 60 % could be achieved for ammonia. Despite the low rate of elutriation (0.27 m³/day) and the greatly increased concentration of the nitrogen content in the washing liquid (up to 8 g N/L) caused by this, which clearly exceeded the maximum value cited in the literature of 3 g /L [3], no decrease in efficiency of the sewage bed reactor was found during the experimental period of three months. The course of the ammonia mass flow, as well as the nitrogen concentrations in the washing liquid, is shown for the second biological experiment in *Figure 2*. With reference to the reduction in odour, in 50 % of the pure gas samples investigated no smell of raw gas could be detected. However, with regard to the odour units measured, only a minimal reduction could be ascertained. In the four-week experimental phase, in which the sewage bed reactor was operated with a groundwater/filtrate mixture (ratio 2:1), no difference with regard to the ammonia efficiency and increased concentration of the nitrogen content in the washing liquid could be ascertained, when compared with the experimental series with pure groundwater.

Conclusion

The ECOWEL® farm system represents an approach for ensuring low-emission processing of liquid manure, in view of the reduction in liquid volume and dust and ammonia emissions. This system is not, at present, fully developed and above all, requires further research; particularly in relation to the pressure filter, which is subject to malfunction. The loam-like consistency of the filter cake regularly resulted in blockages of the pressure filter so that, during the period of experimentation, long-term use of the pressure filter was not possible. Currently, work is being carried out to eliminate this problem.

At present, the process cannot be considered to be economically efficient, as current operating costs for processing 1 m³ of liquid manure are above that of the cost of disposing of the liquid manure via the liquid manure market. As the liquid manure processing installation consists of a number of individual components, in practice, the use of individual modules is conceivable.

In the experiments with biological air scrubbing, the sewage bed reactor produced a constant level of reduction in ammonia (60 %) throughout the whole of the experimental period. It can be concluded from this that a stable working biology was developed in the washing liquid.

Table 1: Overview of the nutrient contents of the single substrate in the liquid manure treatment

	Raw liquid sewage	Inflow SBR	Outflow SBR	Sep. solid material	Dried solid material	Filter cake	Filtrate
N content (NH_4-N, NO_2-N, NO_3-N) [g/L]	3245.65	3211.96	1089.9	n.d.	n.d.	n.d.	367.50
TM [g/100g]	6.55	4.61	2.34	35.85	69.77	17.86	1.09
TC [g/100g]	2.01	2.22	0.72	15.19	30.78	4.11	0.04
TN [g/100g]	0.38	0.44	0.22	0.78	1.45	0.53	0.05
C/N-Verhältnis	5.33	5.09	3.35	19.36	21.20	7.72	0.75
K [mg/100g]		0.26	0.26	0.27	0.44	0.28	0.19
P [g/100g]		0.33	0.14	0.84	1.03	0.88	0.06

n.d. not determined