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Dry fermentation

Development stage and perspectives

When at the end of this year the expected number of on-farm biogas plants in Germany rises well above 1000, then most will be working according to the same basic principle: the substrate to be fermented – usually slurry – must be pump-compatible and repeatedly homogenised. On this slurry basis it is reckoned that there's room for around 200 000 plants in Germany. But what happens on the farms with solid manure systems? The following paper offers some solutions.

Fig. 1: Filling a fermenting box with wheel loader

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The largest natural „biogas factory“ in the world is the rumen wherein, using 2 to 12% of feed energy annually, around 80 million tonnes of methane are produced [1]. This rumen biogas comes from a 17% DM mix and thus would not be pump-compatible. In the meantime, laboratory trials and technical projects show that biomass with up to around 35% DM can fermented to produce methane without further input. Because of the possible higher DM content of the substrate the system is – not quite correctly – called „dry fermentation“, as opposed to the usual wet fermentation with liquid substrate. Appropriate experience in the former system comes from waste treatment [2], from agricultural research plants in Switzerland [3], German research work in Potsdam-Bornim [4] and procedural/technological investigations at FH Weihenstephan/Triesdorf [5]. Whilst FH Weihenstephan department Triesdorf continues with trials for biogas production from net-wrapped round and big square bales, two dry fermenter variants already working on commercial farms can be presented in the following paper.

Box fermenter

Because of positive experience with the batch fermenter [5] the firm Bioferm developed a new type, the box fermenter. This latest and TÜV-certified dry fermenter is a garage-type construction with two prefabricated concrete walled containers each with 112 m^3 capacity. For filling and emptying by wheeled loader there are front-sited hydraulically-controlled doors *(fig. 1)*. The ceiling features an opening for gas withdrawal and the liquid percolate distribution system and a percolate drain in the floor. The percolate is stored in two tanks, one for each fermenter box, and separately operable. The percolate and the farm's individual substrate mixture in dry fermentation are crucially important for the yield and quality of gas. As opposed to wet fermentation with its daily input and extraction of slurry and supply and loss of methane-producing bacteria, in the dry system the bacteria can be retained in the production cycle. This means the methane bacteria become more compatible to the aggregate because they remain and develop from charge to charge and are thus increasingly more productive. The gas itself is stored in a 5 m^3 container at maximum 5 bar. Through an internal control program it is automatically withdrawn as fuel by a 37 kW$_{el}$ small central heating end electricity power station (BHKW). In order to meet the security requirements for TÜV (national standards agency) certification, a sophisticated automatic safety program has been installed. Outwith filling and emptying time of around one hour per charge, no further work is required during the 25 to 30 day fermenting time apart from the recommended daily inspection. For prevention of potential explosive gas mixtures on opening of the fermenter, a sensor-controlled locking system has been installed which only allows the door to be opened when non-dangerous gas concentrations are registered. This involves running the gas mixture through a four-layer biofilter before extraction and ventilating the fermenter with fresh air before opening the door. This ensures an absolute odour-free system. Currently, the 2-fermenter plant, which can be expanded at any time, is sufficient for an annual throughput of 1300 t biomass and is run at the moment with various farm biomasses and municipal domestic biowaste.

Plastic tube fermenter

A variant of a variable batch fermenter is represented by the AG-BAG (from Malschwitz near Bautzen) plastic tube fermenter. Under variable batch fermenter one understands a container which can allow filling and emptying to take place at any time through a sliding layer between fermenter wall and substrate. This method, used for combined methane and compost production, is already known in forage conservation as plastic tube ensiling. The tube is filled via a special press already used in the ensiling process. This works like a sausage filling machine. The substrate ferments in the tube and after methane production is complete composting begins under aerobic conditions after which the plastic is split open, the compost removed, and the plastic taken-back by the producing firm for recycling. Tube diameter is up to 2.3 m and length up to 60 m. Recommended base is a tempered and insulated

Fig 2: Filling the foil hose fermenter

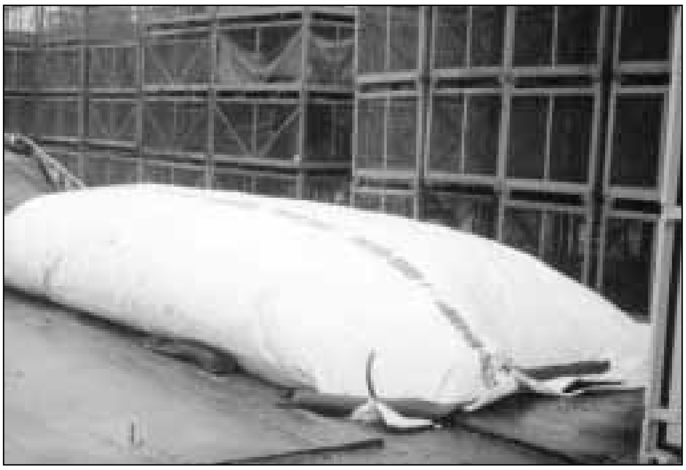

Fig. 3: Hose seal for gas tapping

concrete pad and temperature control is via a flexible „electric blanket“ system. A perforated plastic hose is laid in the tube during filling and this serves for gas withdrawal and later aeration. Special valves and airlocks allow filling of proportions of the bag over a period of time and a simple withdrawal of the gas *(fig. 3)*.

Technology with alternatives

Whilst the above-mentioned variants have already being tested in practice, a whole series of other fermenter designs can be imagined which can be adjusted to meet the requirements of individual farms whereby substantial cost savings through own-labour could be possible. The special advantage of the dry fermenter undoubtedly lies in the modular concept which allows the operator to „grow into“ production technology, and in the fact that the batch system allows different charges can always be handled completely separately from one another and the remaining material disposed of outside the farm. Even if such technologies are still at the beginning, different possibility studies, in part still being continued, show a completely new development potential regarding gas yield and quality. While in conventional wet fermenting new bacteria have to be continually added with the old cultures being washed out, dry fermentation with batch system offers the possibility of using bacteria cultures selected for suitability and exploiting them optimally. As in the fermenting industry, there thus emerge valuable plant-specific substrate-optimised cultures which – meantime results indicate – could probably have a lot of positive potential for increasing the current gas yield and quality limits. Presently, one can only say that with the dry system yields can now be measured in m^3/kg DM just as in wet fermentation. Reserves which could boost future performance through optimised substrate mixes, bacteria cultures and preliminary rotting systems should soon be indicated by current trials. Applications are being made to reduce the sulphur content of biogas which has a significant influence on the working lifetime of BHKWs and the gas' suitability for feeding into the public natural gas network – a possible technical alternative for future energy producers on the farm when the political will creates the right conditions.

Perspectives

The new technology offers other, completely different, on-farm development chances: a realistic path towards possible „energy farms“ or agricultural „energy agencies“. Similar to the system already existing in contract wood chip production for diverse commercial and communal facilities, electricity and heat can now be offered ex-farm. Mobile fermenter modules which per farm can be used to supply up to two mobile BHKWs on a multiform cooperative basis enables new income possibilities and farm-cooperation activities. Practical opportunities lie especially with heat sales (swimming bath and greenhouse heating, hall climate regulating and diverse drying tasks) which are not, or only partly, possible with farm-bound wet fermentation. Finally, new possibilities are opened in the cooperation between several farms as raw material suppliers, energy producers and marketers. The agriculturalist as possible energiculturalist has new opportunities within the concept of multifunctional farming.

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