November 2014

Sludge to Energy Enterprises in Kampala (SEEK)

Operational Report: Pelletizing of faecal sludge with the Bioburn® Pelletizer in Switzerland

Background

The objective of this study was to investigate whether faecal sludge (FS) collected from onsite sanitation technologies in Switzerland can be transformed into fuel pellets with the bioburn® pelletizer (model: BPM-X108, see fig. 1). Further information on the technology is available on www.bioburn.ch. This study was conducted as part of the SEEK (Sludge to Energy Enterprises in Kampala) project funded by REPIC (www.repic.ch) and the Symphasis Foundation (www.symphasis.ch). Information on the project and its partners is available on www.sandec.ch/seek.

Bioburn® Pelletizer

Compared to conventional wood pelletisers which can palletise dry and fine grounded feedstocks, the bioburn® pelletizer can process feedstock with a percent dry matter (%DM) between 60 and 80 and particle sizes of up to 2 cm. The bioburn® pelletizer comes with an extruder technology. This extruder leads to twisted pellets with a higher strength than layered pellets from a conventional pelletizer. This is beneficial for pellets transport and storage. The bioburn® pelletizer is also more energy efficient. It requires only 50% of the energy that a conventional pelletizer would require. And for feedstocks with a calorific value of 4.5 kW/h only 7% of the energy is consumed by the bioburn® pelletiser.

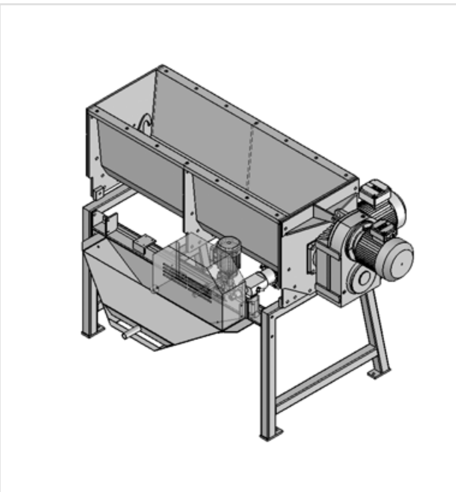

Figure 1: Bioburn Pelletizer

Faecal Sludge Drying

Methodology

As a first step. FS needed to be dried for pelletizing. The Bioburn pelletizer performs best at 65% DM of the feedstock. In Switzerland, only few households in rural areas rely on septic tanks whereas the majority is connected to the sewer. Therefore, as a first step, a FS collection and transport company (Vonwyl, Ettiswil, Switzerland) in Switzerland was identified. The transport company delivered the FS for experiments to the Bioburn Laboratory in Zell, Switzerland. The FS was discharged directly from the truck onto the pilot-scale drying bed (see fig. 2).

The drying bed was constructed out of a Euro-pallet and a 1200x800x400mm pallet frame (see fig. 2). A punched sheet combined with a fine-meshed net was used as drying bed filter (see fig. 3). The large diameter of the filter led to discharge of some solids with the effluent. However, drying of sludge for pelletizing had priority over effluent quality. The drying process was supported by intense solar radiation and high temperatures of around 30°C during this period.

Figure 2: Pilot-scale drying bed

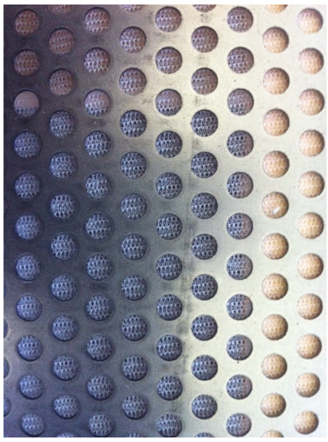

Figure 3: Filter of the pilot-scale drying bed

Results

- More solids would have been retained on the pilot-scale drying bed with thickened FS and if another drying bed design and filter would have been used.
- FS had 75%DM after six days which was already too dry for optimal pelletizing (65 %TS).
- The dried FS had the following characteristics.
    - 75%DM
    - Structure: porous, very dry, papery, light, some fibre
    - Colour: dark with bright points

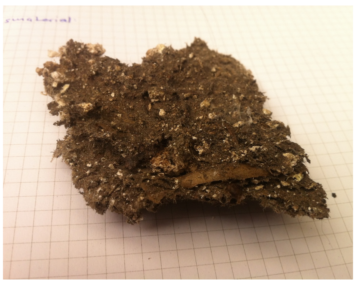

Figure 4: Dried FS from pilot-scale drying beds

Faecal sludge pelletizing

Methodology
The dried FS was divided into three batches (Sample A, B, C) and the %DM was reduced to different levels by addition of water:
Sample A: 70%TS
Sample B: 65%TS
Sample C: 60%TS

%DM was measures using a hand moisture meter. As hand moisture meters are less accurate then %DM analysis by Standard Methods (www.standardmethods.org) the results should only be compared within this study. During pelletizing the process temperature was measured with a Greisinger temperature meter (model: GTH 1150) on the nozzle where the pellets pass out. %DM of the pellets was measured one hour after pelletizing. The pelletizing rate was monitored qualitatively.

Results

Sample A: 70%DM
- Process temperature: 69°C
- Good pelletizing rate
- Hard pellets of good quality
- Moisture after drying: 80%DM

Sample B: 65%DM
- Process temperature: 64°C
- Good pelletizing rate; higher than Sample A
- Hard pellets of good quality; less hard than Sample A
- Moisture after drying: 74%DM


Figure 5: FS Pellets Sample B

Sample C: 60%DM
- Process temperature: 60°C
- High pelletizing rate; partially to fast
- Lower pellets quality than Sample A and Sample B
- Moisture after drying: 67%DM

- The added water didn't combine well with the dried FS. Therefore, the moisture was not uniformly distributed.
- The added water increased the pelletizing rate.
- The added water decreased the process temperature.
- High process temperatures enhance post-drying of the pellets. All experiments showed temperatures between 60-64°C. This is low compared to 90°C measures on a previous experiment with horse dung. This results in lower %DM of the pellet, which was between 67-80.
- The pellet quality decreased with decreased %DM, although all pellets showed a sufficient quality. Only Sample C showed low quality due to the high pelletizing rate. A minimum contact time is required to allow sufficient compression of the feedstock into pellets.

Conclusions

- The experiments showed that FS can be pelletized with the bioburn® pelletizer. All experiments showed a sufficient throughput and quality of the pellets.
- Additional water was added to the dried FS to reach 60 and 70%DM. This was not ideal as the water was manly on the surface and did not well distribute within the material. Previous experiments with pelletizing of horse dung showed, that free water on the surface accelerated the pelletizing rate while bounded water did not. Therefore, if the majority of water in FS is bound, as is the case for FS from drying beds in Kampala, we can produce quality pellets at lower %DM.
- Process temperatures in all experiments were low. This could be attributed to the material structure. FS is structured very homogenous and contains only small particles. Therefore, it passes gently through the extruder with low friction. Would it contain also lager particles (e.g. straw, saw dust) the friction increases and so does the process temperature. A higher process temperature would increase post-drying of the pellets. Experiments with horse dung showed that with a process temperature of 90°C the pellet dried up passively to 90%DM without any energy input. The added water lowered the friction further as it acted as an anti-friction agent. For a final assessment further experiments are required with FS in Kampala.
- The drying bed used as part of this study had the advantage that no additional sand was added to the FS during drying which would have increased the ash content and lowered its energy value. Furthermore, sand hinders the pelletizing process, increases abrasion of the extruder and maintenance costs. For optimal fuel quality and low maintenance costs the design and operation of conventional sand drying beds needs to be improved.
- The experiments showed that FS with 60%DM could be processed to pellets in acceptable quality.
- Based on the results of this study, we conclude that FS with 60%DM can be processed into quality fuel pellets. With addition of dry biomass (e.g. straw with 85%DM), FS with lower %DM could be pelletized, as mixing increases final %DM. In this way, process temperature and post-drying of pellets after pelletizing could be enhanced.