water for people

Making Briquettes from Faecal Sludge

Fact Sheet
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BACKGROUND

Water For People, with support from Water Research Commission (WRC), ICCO cooperation and UNICEF Finland, has been carrying out research in production of faecal sludge briquettes for over 2 years and is presently promoting its production in Kampala and Lira with prospects of scale up in other districts.

INTRODUCTION

Biomass is still the most important source of energy for most of the Ugandan population. About 90% of the total primary energy consumption is generated through biomass, which can be separated in firewood (78.6%), charcoal (5.6%), and crop residues (4.7%) (Avellino *et al*. 2018). Such situation imposes pressure on the natural forests, hence causing climate change. Several groups of people have started venturing in using organic solid waste and charcoal dust to make briquettes, which are slowly becoming popular in market. The main challenge that they face is sorting the waste, competition with animals (for example, with banana peels) and efficient ways of carbonization.

One clear organic resource waste that has not been fully exploited is faecal sludge. Appropriate ways of disposing and safe reuse of faecal sludge are also still limited to a few applications like agriculture. Even then it's supposed to be applied under strict guidelines to avoid spread of pathogens and other pollutants back in food chain.

The most compelling argument over its commercial value is based on the price of the timber-based charcoal widely used. A bag of such charcoal costs an average of UGX 100,000 (US$26) for a large sack and will keep a single burner alight for approximately 48 hours. UGX 100,000 will also buy 50 honeycomb sludge-based charcoal briquettes and give a total of 210 hours of burning time. The briquettes are 4.4 times more cost effective than the normal charcoal.

FAECAL SLUDGE BRIQUETTING PROCESS

There are six major steps involved from raw sludge to briquettes (Figure 1).

Figure 1: Faecal sludge briquette process

Dewatering and Treatment

In this stage, raw sludge undergoes a dewatering process. Dewatering refers to sludge reduction by volume and weight to ease handling and transportation. The focus here is removal of water to influence sludge volume reduction. There are two stages involved.

Primary sludge dewatering

Dewatering takes place in the pre-settling tank, dewatering/biodigestion tank, and in the anaerobic baffled reactor units. Depending on the moisture content of the raw sludge, these desludging operations can occur at different time intervals. The pre-settling tank and biodigestion/dewatering tank should be desludged when they are 2/3 full.

Secondary dewatering on the non-planted drying beds

The sludge is put on non-drying beds roofed with transparent sheets (Photo 1) to avoid environmental interference of the drying process, especially in areas with different forms of precipitation. Environmental control ensures steady production process irrespective of the weather.

Photo 1: Faecal sludge treatment plant

Most non-planted drying beds have sand layers. Extra attention should be given while removing the sludge for briquettes to minimize sand contact with the sludge. This is because sand has a negative effect on calorific values while increasing the ash content.

Drying

Most drying beds can dewater up to 60% dryness after about 3 weeks for most plants under natural conditions similar to Uganda. At this stage, the sludge is still too wet to carbonize and should be exposed on racks for further drying. It is necessary to dry to at least 90% dryness before carbonization to ensure that briquettes do not give off a smell undesirable in domestic applications. This takes place in an additional sludge storage shade or a modified sludge greenhouse (Photo 2).


Photo 2: Drying in sludge greenhouse and sludge storage shade

Carbonization

This is the most challenging part of making briquettes out of sludge as available techniques better suit wood and municipal solid waste, rather than faecal sludge carbonization. We have experimented with two kinds of kilns, masonry insulated retort and metallic kilns (Photo 3).


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Materials required for carbonization:

- Charring unit or retort kiln
- Dry sludge
- Start-up fuel
- Source of fire

The process of carbonization is summarized in the following steps:

1. Start-up fuel (wood, charcoal, or briquettes) is heated until it turns red hot, then is put and spread in a clean and dry charring unit.
2. The dry sludge is uniformly muffled all over the red-hot fuel until the unit is filled up.
3. As the sludge continues to burn, it reduces in volume so you can keep refilling the unit. The unit is left open to support continuous burning of the sludge; later fire eventually penetrates to the topmost sludge. This may take up to 4-5 hours.
4. The unit is fully air locked to allow the carbonized material to cook and cool all night.
5. In the morning, the sludge is fully carbonized, cooled and ready to be used in the briquettes production process.

Blending and Binding

Once the sludge has been carbonized, the following steps are carried out before briquetting takes place:

1. Crush carbonized char into fine particles (Photo 4)
2. Blending and application of binders

Several kinds of binders can be used such as starch, cassava, molasses, clay, etc. The current briquette production process uses molasses, which is a better binding material than the starches, and clay. Three-four litres of molasses and 6-10 kg of clay mixed with 40 litres of water is combined with 200 kg of charcoal dust and carbonized faecal sludge char. The charcoal dust and carbonized faecal sludge char are at a ratio of 60:40 which was found to give most appropriate combination that can compete favorably with the briquettes and wood charcoal sold on the market in terms of burning time, energy content, quality, price and durability.

Photo 4: Crushing carbonized char and blended material ready for briquetting

Extruding, Molding and Drying

After the blending stage, a normal produce for ordinary briquettes is followed, and the following techniques below have been applied: Once this is done, the briquettes are dried on racks (Photo 5).

Photo 5: Briquettes drying on racks

Hand/manual presses: Use a simple mold and hammer the blended mixture together. There are a considerable number of designs that have been disseminated across rural areas in developing countries lacking electricity supply. Hand briquetting requires only a low investment but is very labor intensive.

Screw extruders: In a screw press or screw extruder, the rotating screw takes the material from the feed port, through the barrel and compacts it against a die which assists the build-up of a pressure gradient along the screw (Photo 6). The important forces that influence the compaction of the feed material play their role mostly in the compression zone near to the extrusion die.

Photo 6: Stick Screw Extruder

Honey comb machines: Honey comb briquettes can be made easily and cheaply using manual machines (Photo 7)**.** However, motorized machines are also available.


Photo 7: Honey Comb Machine (manual and motorized)

BRIQUETTE USAGE

Below is a step process taken to light and use the briquettes.

Honey comb briquettes (non-reusable)

1. Fix red-hot fuel or fire starter in the liner of a stove.
2. Hold the briquette with both hands to fix it in the liner, make sure that the holes in the briquette are directly proportional to those in the stoves liner.
3. It may take approximately 20 minutes to catch fire, then keeps burning for more than 6 hours (Photo 8).
4. No need to steer or shake to reduce ashes.

Photo 8: Honeycomb briquette lighting in cook stove

Stick briquettes

1. Break the briquettes into a reasonable size to fill up the stove.
2. It's advisable to use in a vertical arrangement.
3. Break a fire starter into half, light it, and fix it amidst briquettes.
4. It takes 5-10 minutes to catch fire (Photo 9).
5. Don't shake the stove when refilling; use a stick to stir.

Photo 9: Stick briquettes lighting in cook stove

Energy content of briquettes

The energy content or calorific value (CV) was measured at Centre for Research in Energy and Energy Conservation (CREEC) at the College of Engineering, Design, Art and Technology. The CV is the amount of heat released during the combustion of a specific amount of fuel. It is expressed in kJ/kg. Various briquettes have been made with charred faecal sludge blended with other materials like charcoal dust and binder. There are 100%, 80%, 60%, and 40% faecal sludge composition briquettes. It is measured with the use of a 6400 Automatic Isoperibol Calorimeter.

Figure 2 shows the average CV from each briquette given the percentage of charred faecal sludge in comparison with wood charcoal.

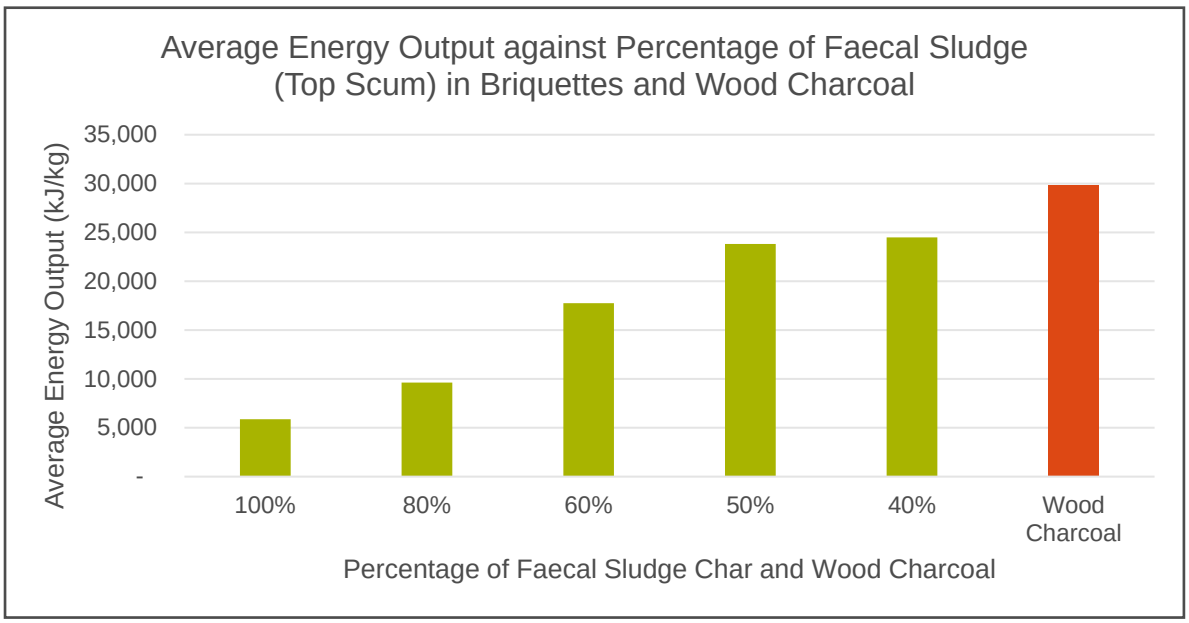

Figure 2: Average gross energy output (kJ/kg) against percentage of faecal sludge

Briquette production from faecal sludge may involve some health risks especially if the process involves dealing with raw sludge and the common route is faecal oral. However, after carbonization the product is completely pathogen free and the briquettes are safe from pathogens. Below are the steps to ensure elimination of contamination and achieve safety.

1. **Separate the two key stages: treatment and briquette production**

The process of carbonization kills all pathogens at high temperatures, making the product safe from biological contamination. This stage emits dust and particulates; therefore, handlers should ensure the nose and mouth mask is on. This applies to dry faecal sludge and char.

2. **Separate the tools used and mark them properly**

Tools under production area should never cross the carbonization unit area to minimize possibility of contamination.

3. **Drying process**

Never dry faecal sludge on same racks or solar dryers as ones where briquettes are dried. This is necessary to minimize post contamination of briquettes.

4. **Wind direction**

Wind may blow some particles from drying faecal sludge to final product, which is briquettes. Ensure the distance between the two is more than 30m for unroofed drying racks or locate in different wind direction.

5. **Handwashing and changing of attire**

While crossing from treatment side to production side, always wash hands with soap and change the protective gear.

6. **Safety marks**

Put safety marks to remind people about associated risks at each stage in process.

Applications of Briquettes

Briquettes can be used for a variety of purposes such as:

- Household cooking
- Institution cooking
- Poultry brooding
- Sauna and house warming
- Industrial applications

There is an opportunity for reusing faecal sludge as a fuel source in the form of briquettes. Water For People is committed to continuing with the research process of optimizing faecal sludge with other organic materials in our effort to reduce the carbon footprint while safely managing faecal sludge.

Reference Information

Avellino, O. W. K., Mwarania, F., Wahab, A. H. A., & Aime, K. T. (2018). Uganda Solar Energy Utilization: Current Status and Future Trends. *Published in international journal of scientific and research publications*, *8*(3).

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