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%) (Energypedia nd). 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).

- **RAW SLUDGE**
- **DEWATERING & TREAMENT**
- **DRYING TO 90%**
- **MOULDING, BRIQUETTE & DRYING**
- **BLENDING**
- **CARBONIZATION**

*Figure 1: Faecal sludge briquette process*
A. 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 as listed below;

1. 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.

Photo 1: Faecal sludge treatment plant

B. 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/ sludge storage shade

C. CARBONIZATION

This is the most challenging part of making briquettes out of sludge because available techniques do not suit faecal sludge carbonization but that of wood and municipal solid waste. We have experimented with two kinds of kilns, the masonry insulated retort kiln and metallic kilns (Photo 3).

Photo 3: Metallic charring drum

Materials required for carbonization:

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

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. Then the unit is fully air locked to allow the carbonized material to cool and cook all night.
5. In the morning, the sludge is fully carbonized, cooled and ready to be used in the briquettes production process.

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

D. BLENDING AND BINDING

Once the sludge has been carbonized, the following steps are carried out before briquetting takes place (Photo 4):

1. Crush carbonized char into fine particles
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
E. 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 7).

**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 5). The important forces that influence the compaction of the feed material play their role mostly in the compression zone near to the extrusion die.

**Honey comb machines:** Honey comb briquettes can be made easily and cheaply using manual machines (Photo 6). However, motorized machines are also available.
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.

For more information, contact Water For People Uganda
Plot 2A Katalima Bend, Naguru, Kampala
www.sanihub.blogspot.com | cnimanya@waterforpeople.org

**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: Average gross energy output (KJ/kg) against percentage of faecal sludge**

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

**APPLICATIONS OF BRIQUETTES**

Briquettes can be used for a variety of purposes as listed below;

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