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Biomass production

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Biomass production

Renewable energy is the energy obtained from naturally repetitive and persistent flows of energy occurring in the local environment. It includes energy from solar, wind energy, energy from biomass, energy from water, geothermal energy and tidal energy. Renewable energy becomes sustainable if it can be properly used in the current without compromising needs for the future. Renewable energy can be obtained from various sources which includes wind, water and biomass. Wind and water energy requires high levels of investments since they are capital intensive whereas energy from biomass can be produced on small, medium and large scale industries. Biomass is the organic, carbon based material that reacts with oxygen in natural metabolic processes to release energy. The initial material may be transformed by chemical and biological processes to produce biofuels (Twidell, 2015).

The term bioenergy is used to describe both biomass and biofuels. Bioenergy is by far the most used renewable energy resource by energy value being about 10% of the total global primary energy supply. This is possible when non-commercial firewood for cooking and commercial use of wastes are included. Despite the historic use of biofuels, there is great potential for more energy efficient and sustainable use in both developing and developed countries. Energy from biomass can be harnessed in 3 different forms and that is to say in liquid form, gaseous form and solid form (Twidell, 2015).

In Uganda, the widely used source of energy is wood both as firewood and charcoal. This is used by people in both towns and villages. Electricity is also used in some parts of the country connected to the grid mainly for lighting and not cooking because of the high bills it comes with. In the last 100 years, Uganda's forests have faced severe pressures mainly from agricultural conversion as a result of population increase, urban demand for charcoal, over grazing, uncontrolled timber harvesting and policy failures. The forest cover has shrunk from 10 million ha in 1890 to 3.6 million ha in 2005 [2] The continued pressure on trees destruction for wood is still inevitable since the majority of the people burn wood for fuel. This makes the greenhouse gas effects inevitable. On top of the greenhouse gas effects, there is rapid population increase in the country and this means that usage of essential products like beverages and foods is high. These beverages and foods are packaged in bottles and bags made of polymers. Generally, the world's annual plastic consumption had increased from 5 million tonnes in 1950s to nearly 100 million tonnes by 2009 (Into, 2019.). It is also said that the world production is expected to be 644 metric tonnes by 2035 and this continues to create a threat to the ecosystems [4]. Now these plastics are disposed off to landfills and because they are non-biodegradable, they cannot decompose easily (*KCCA Report*, 2018).

Plastics are organic polymers which have molecules containing long carbon chains as their backbones with repeating units. The structure of these repeating units and the type of atoms play the main role in determining the characteristics of these plastics. The long carbon chains are well packed together by entanglements and van der Waal forces between large molecules and form a strong usually ductile solid material. Also additives are usually added when manufacturing commercial plastics in order to improve on the strength, durability and other physical and chemical characteristics. There are 2 types of plastics and that is to say thermoplastics and thermosets. Thermoplastics can be reheated, melted and molded into different shapes while thermosetting plastics will char[6]. Thermo setting plastics without halogens like chlorine and sulphur can be used to act as a binder for biomass in order to provide an alternative fuel other than wood.

Methodology

The biomass available is in form of rice and maize husks, bagasse from sugarcane, and also kitchen refuse which have to be first dried. The main concentration will major on the rice and maize husks because it is available in tonnages at the agro-processing industries. These can be used as solid fuel when prepared using a briquetting machine to produce pellets. The briquetting machines can be fabricated locally by the local artisans. They can be motor driven or manually operated depending on the magnitude of the pellets to be made.A hydraulically operated briquette contains frame, hydraulic jack, piston and compression cylinders. Rice husks are used as the main biomass while the binder used here is the polyethylene plastic. This is commonly known as black peel (by Ugandans). It is very commonly used a packaging material. The compression ratio is less than 0.3KN/m^2 (Agidi, 2017). For a good pellet then, a binder should be 40% of the total composition. Polyethylene plastics can be subjected to heat of 120^0c for LDPE and around 180^0c for HDPE respectively. At this point, they can be mixed with rice husks and then stirred to mix completely. The mixture is meant to pass through a briquette making machine while still at an elevated temperature. The elevated temperature is to ensure the plastics do not solidify before the pellets are made.

A simple briquette making machine for production of these pellets can be explained below. The machine has 2 major components. That is to say the mixing chamber and the extruder. The figure below is the flow diagram for the pellet making process.

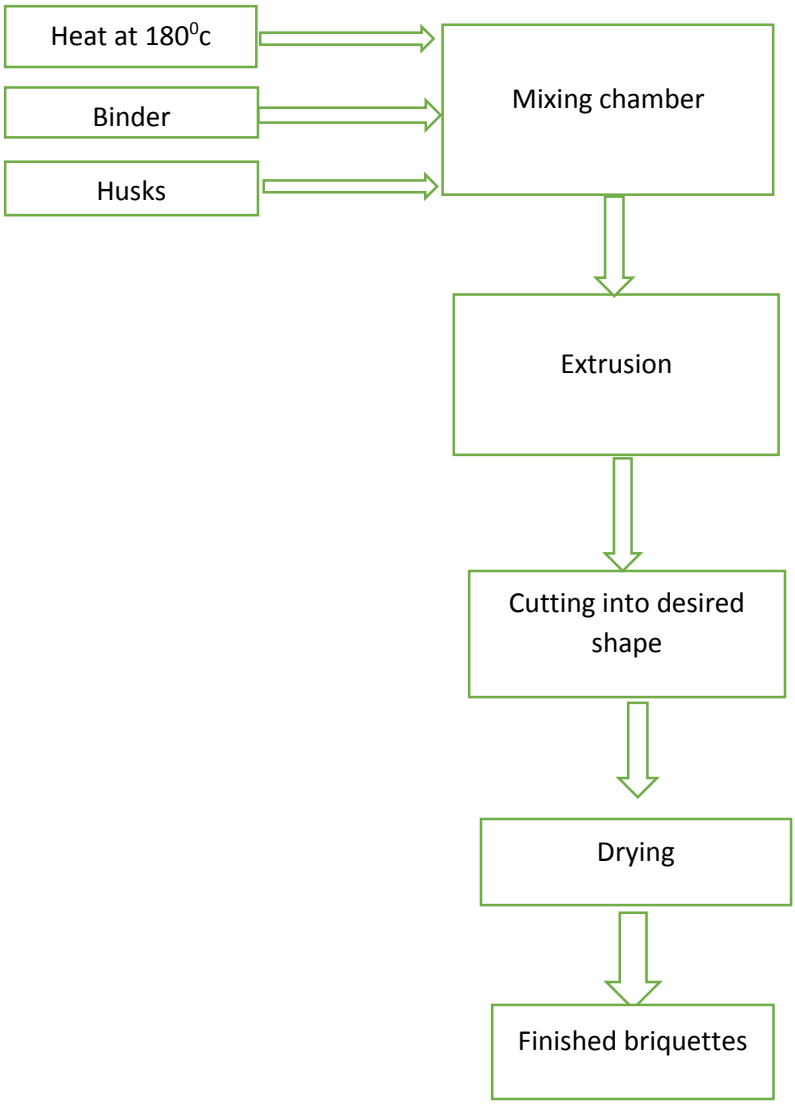

Figure 1: Showing the flow diagram for the production of briquettes from rice husks

Technical explanations.

Wood has got its calorific value to be between 3500-4600kcal/kg. The calorific value of rice husks is as low as 3200kcal/kg. However, with the introduction of 40% plastics as a binder in the rice husks this calorific value improves significantly. This is because plastics have a higher calorific value than wood and husks. This means that using this briquette will provide more heat to a certain given mass saving time. The air fuel ratio should be appropriate to reduce on the smoke that can result in case of incomplete combustion just like in any other fuel. The raw material first needs to be ground into small particles (but in this case the husks are already in small particles) and then carbonized to char and then compacted into briquette [8]. The method of carbonization used here is steel and brick kiln which has a higher efficiency than the traditional method of earth pit kilns whose sample is shown in the figure below;

Figure 2: Brick built kiln used for carbonizing bagasse and a cylindrical mixer

Binding is the process of bringing the particles together in order for them to form a uniform shape. In high temperatures, naturally occurring material called lignin can be melted and it can act as glue under high pressure. However, for this scenerials, a plastic binder will be used in attempt to increase the calorific value and also reduce on the environmental pollution [8].After binding, the mixture passes through an extruder that in turn transforms these inputs into briquettes which are later dried to make them ready for use as a source of fuel.

Another type of fuel is to combine bagasse from sugar factories with molasses and clay as a binder to produce chips that can be used as solid fuel. The process of production starts with carbonization of bagasse in steel brick kiln followed by grinding both the carbonized bagasse and clay together to form powder. The grinding is done in local fabricated machines that operates on the principal of a posho mill [9]. The grinding is important as it increases the surface area during bonding. The carbonized powder of bagasse and clay together with molasses are now mixed thoroughly in a mixer which can be fabricated locally. The mixer is used for large scale production while for small scale, a simple basin can be used and the mixing done manually by hand. The proportion of clay to molasses to charcoal should be 1:2:10 in that ratio otherwise higher proportions of clay will lower the resultant fuel heating value. Water should also be sprinkled to the mixture to provide to ensure proper bonding [9].

The briquettes can now be dried to remove moisture in them and then store them ready for cooking. 2 kg of these briquettes can be used to boil 2000mls of water to boiling point. 5 bags of raw bagasse can be used to produce 1 bag of carbonized bagasse [9]. Now by 2015, Kakira sugar company alone had 31,000 tonnes of unused bagasse [10]. There are more than 10 sugar companies in Uganda and the number of tonnes of bagasse damped is expected to be more than 100,000 tonnes annually. This means that if the bagasse is utilized for briquette production, 100,000 tonnes can produce 20,000 tonnes of briquettes. However, the production may go beyond this if proper calculations are done. This resource can help reduce pressure on charcoal which was consumed highly in around 300,000 tonnes in Kampala alone according to the national charcoal survey for Uganda 2015 [11].

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