Defining Briquettes

- Block of compressed coal dust, charcoal dust, sawdust, wood chips or biomass.
- Agglomerating (binding) material added to charcoal dust + apply pressure to mixture to form a briquette.

Charcoal Briquette Ingredients and Composition (same ingredients can still apply for other heat fuel sources)

Usual ingredients include:

- Heat fuel - wood charcoal, charcoal fines, mineral carbon, coal, biomass, etc.
- Burning speed – sodium nitrate and waxes. Sawdust can also be used.
- White Ash Color - Calcium carbonate, lime or limestone
- Binder – starch. Cement, kaolin, ball clay can also be used
- Press release – use borax
- Filler – for adulteration use silica, clay, soil, etc

Heat Fuel

- Provides the energy (the higher the percentage → the better the briquette).
- 90% heat fuel is ideal.
- Get materials that will emit less ash (ie not charcoal fines from tree leaves → as they have lots of dust and soil therefore will yield more ashes)
- Use larger fines and crush them to appropriate size.
- Heat fuels: wood charcoal, charcoal fines, mineral carbon, coal and biomass.

Accelerants

- Chemical nitrates (sodium nitrates especially)
- Problem is that they are expensive → may not be priced well to compete with lump charcoal.
- Nitrates will also provide heat. → are oxidants and therefore give out oxygen for accelerated combustion.
- Not viable for low end markets though.
- Instead used sawdust as accelerant (use 10-20%).
- Note that un-carbonized sawdust will make your briquettes emit a lot of smoke.
- To reduce smoke - partly ferment sawdust (soak in water for 5 days).
- OR you carbonize briquettes after they're made (too hard would require a Round self ignite carbonization furnace).

White Ashes

- Just used to see when briquettes are hot.
- Contain calcium carbonate lime or limestone. Can also lower burning rate of fuels however can be expensive though.
- Therefore not necessary in developing countries and in our case.

Briquette Binders

- Starch best binder. Any starch is okay but preferably from cassava.
- Cassava starch preferred as tuber (high starch content) and chips are very cheap
- Also used in low income societies hence accessible.
- Corn (maize) starch, wheat starch, maize flour, wheat flour and potatoes starch, cassava (tapioca).

How to use starch as a binder:

- Break down intermolecular bonds of starch molecules in hot water to form a thick paste that will stick the charcoal dust together.
- Can use lignin (cell wall constituent) from biomass material
- Starch can cost $1 per 1kg. (5-7% required in briquette).
- For 45kg of charcoal (costs about $10) you need 2-3kg of starch (costs $2-3).
- Mashed newsprint/waste paper pulp can also be used as binder.

Press Release:

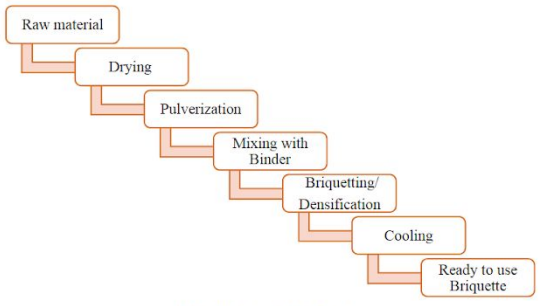
- Borax or Sodium Borate used in higher pressure briquette machines to release briquette from charcoal.
- Not necessary if using manual/simple press.

Fillers:

- Not necessary
- Can however be used to compete with lump charcoal. Can add fillers and then lower your prices.
- Clay and sandy soil can be used as a filler (filler has to be cheaper than charcoal fines themselves).

Methods of making briquettes:
https://www.youtube.com/watch?v=OmNio9g7dH0

How to make briquette mixture out of newspaper, water and sawdust:
https://www.youtube.com/watch?v=OspPTUnG86A



How to make big brick briquettes using shredded paper, water and sawdust:
https://www.youtube.com/watch?v=BHgBCvQ_-Qg

- Note the following link provides a burn test of the briquettes (take 45 mins before the flame dies → https://www.youtube.com/watch?v=KKoK3D8zwdY

Main steps to setting fire to used coconuts:

- Can light coconuts using its own coconut husk with ash rolled inside it.
- Cook coconuts in oil drum.
- Once fire is started cover the top of the drum and let all the coconut burn.
- Then can grind the coconut into charcoal.

Charcoal and charcoal briquettes, what is the difference?

Charcoal is a porous black solid, consisting of an amorphous form of carbon, obtained as a residue when wood, leaves, or other organic matter is heated in the absence of air. Figure 1 showing charcoals made from wood.

When fuels such as wood, and charcoal are burned, only part of the total energy of the fuel is effectively utilized. This useful energy component is called the thermal energy yield, often expressed as a percentage of the total energy available in a kilogram of raw material.

A cubic metre of wood varies considerably in weight; from 215 kg per cubic metre of twisted branches of shrubs up to 600 kg for cubic metre of well-shaped wood from thinning operations. The average yield of charcoal-making process (carbonisation) varies from 16% to 30% of the weight of the raw material (eg. 1 kg of wood will produce 0.16 to 0.30 kg of charcoal after the charcoal making process), the drier the wood used, the higher the yield will be.[1]

Carbonisation process is a chemical process (also called pyrolysis) that breakdown of complex substances into simpler ones by heating, complex carbonaceous substances such as wood or plants are broken down by heating into elemental carbon and chemical compounds which may also contain some carbon in their chemical structure.[2] The first step of carbonisation would require the kiln is drying out of the wood at 100°C or below to zero moisture content, the temperature of the dry wood is then raised to about 280°C. At 280°C, wood or plant material begins to spontaneously break down to produce solid charcoal plus water vapour, methanol, acetic acid and another complex chemical, and non-condensable gas consisting mainly of hydrogen, carbon monoxide and carbon dioxide.[3] The three major factors which influence the conversion yield during carbonisation:

- The moisture content of the wood at time of carbonisation.
- The type of carbonising equipment used.
- The care with which the process is carried out.[4]

Although carbonisation causes a loss of energy, the charcoal produced gives a higher yield in use than wood during burning process. When using a three stones stove, the average thermal energy yield of wood is 8% to 5%, charcoal has a thermal energy yield of about 28 percent.[5] Overall, the calorific value of dry wood and charcoal is approximately 14,400 – 17,400 kJ/kg, and 29,600 kJ/kg.[6]

A **charcoal briquette** (or briquet) is a compressed block of coal dust or other combustible biomass material such as charcoal, sawdust, wood chips, peat, or agriculture waste used for fuel and kindling to start a fire. Often when biomass such as twigs, leaves and grass are carbonised, they break down into small pieces or fine powder which is difficult to burn as it is hard to arrange adequate airflow through a fire of these small pieces, it is tended to be drawn up and out of the chimney by the draught, giving visible black smoke. Figure 2 showing the difference between charcoal and charcoal briquettes, with the briquettes takes extra steps with pressing into a shape.

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[1] Keita, J. (2016). *Wood or charcoal - which is better?*. *FAO Corporate Document Repositor*. Retrieved 26 July 2017, from http://www.fao.org/docrep/s4550e/s4550e09.htm

[2] Keita, J. (2016). *Wood carbonisation and the products it yields*. *FAO Corporate Document Repositor*. Retrieved 26 July 2017, from http://www.fao.org/docrep/x5555e/x5555e03.htm

[3]

[4] Keita, J, *Chapter 4 - Carbonisation processes*. (2017). *FAO Corporate Document Repository*. Retrieved 26 July 2017, from http://www.fao.org/docrep/X5328e/x5328e05.htm

[5] Keita, J. (2016). *Wood or charcoal - which is better?*. *FAO Corporate Document Repositor*. Retrieved 26 July 2017, from http://www.fao.org/docrep/s4550e/s4550e09.htm

[6] *Fuels - Higher Calorific Values*. (2017). *Engineeringtoolbox.com*. Retrieved 26 July 2017, from http://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html

According to Singh (2012), when making charcoal powder, 5 kg of paper and cardboard takes 15 minutes to char, 6 kg sugarcane bagasse and dry leaves takes no more than 15 mins, and 12 kg of cotton stalk takes 20 minutes to char. As charcoal dust can not hold into shape without adding a binding material, a starch base binding material is required. Any starch is suitable but preferably from cassava, as cassava starch is preferred because cassava is cheap, easily available in developing country. [7]

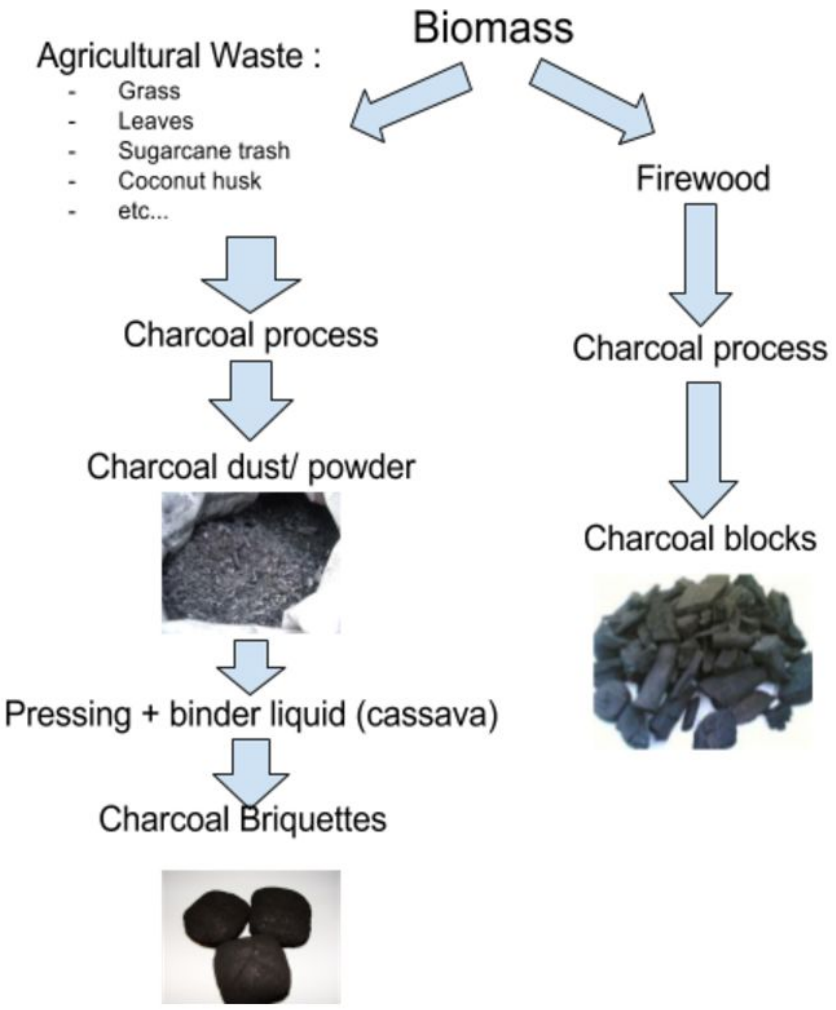

Figure 2. The difference between charcoal and charcoal briquettes.

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[7] Singh, R. (2017). *Charcoal Briquettes - Converting Waste into Charcoal*. India: Appropriate Rural Technology Institute Presents.