DESIGN AND FABRICATION OF BIOMASS BRIQUETTING MACHINE

AshishChakole ,GauravAgrawal , AjinkyaDeshpande , PalashZade , Anukul Jena

Under the guidance of Prof. P.G. Mehar
Department of Mechanical Engineering, KDK College of Engineering, Nagpur

1. ABSTRACT

Many of the developing countries produce huge quantities of agro residues but they are used inefficiently causing extensive pollution to the environment. The major residues are rice husk, coffee husk, coir pith, jute sticks, bagasse, groundnut shells, mustard stalks and cotton stalks. Sawdust, a milling residue is also available in huge quantity Apart from the problems of transportation, storage, and handling, the direct burning of loose biomass in conventional grates is associated with very low thermal efficiency and widespread air pollution. The conversion efficiencies are as low as 40% with particulate emissions in the flue gases in excess of 3000 mg/ Nm2.

In addition, a large percentage of unburnt carbonaceous ash has to be disposed of. In the case of rice husk, this amounts to more than 40% of the feed burnt. As a typical example, about 800 tonnes of rice husk ash are generated every day in Ludhiana (Punjab) as a result of burning 2000 tonnes of husk. Briquetting of the husk could mitigate these pollution problems while at the same time making use of this important industrial/domestic energy resource. The briquettes can be used for domestic purposes (cooking, heating, barbequing) and industrial purposes (agro-industries, food processing) in both rural and urban areas.

Thus Biomass briquetting is the densification of loose biomass material to produce compact solid composites of different sizes with the application of pressure. Briquetting of residues takes place with the application of pressure, heat and binding agent on the loose materials to produce the briquettes. The potential of biomass briquetting in India was estimated at 61,000 MW, while the estimated employment generation by the industry is about 15.52 million and the farmers earn about $ 6 per ton of farm residues. The end use of briquettes is mainly for replacing coal substitution in industrial process heat applications (steam generation, melting metals, space heating, brick kilns, tea curing, etc) and power generation through gasification of biomass briquettes. Being derived from renewable resources, the briquette has superior qualities as well as environmental benefits in comparison with coal.

2. INTRODUCTION

Energy is the key factor in economic development of a country. Global energy use is rising very rapidly, and as emerging markets continue to grow, build-out their vital infrastructure and create the consumers of tomorrow, the world will continue to see energy demand skyrocket. To that end, both investors and governments have been exploring solutions, such as efficiency measures and renewable energy generation as a way to satiate that exploding demand. The use of biomass residues and wastes for chemical and energy production was first seriously investigated during the oil embargo of the 1970s. Households in rural India are highly dependent on firewood as their main source of energy, partly because non-biofuels tend to be expensive, and access to affordable fuel alternatives to coal, gas, kerosene and electricity for cooking and heating is limited.

Biomass briquetting is the densification of loose biomass material to produce compact solid composites of different sizes with the application of pressure. Briquetting of residues takes place with the application of pressure, heat and binding agent on the loose materials to produce the briquettes.

The raw materials for biomass briquetting can be:

- Agricultural residues (husks, cob, stalks, leaves, stems, shells, sticks)
- Invasive plants
- Waste from bio-product industries like sawmills, plywood industries, furniture factories.

Due to the present world's energy crisis and its related environmental issues as well as increasing trend of fossil fuel prices, renewable energy source is an essential matter. Biomass briquettes are a renewable source of energy and they avoid adding fossil carbon to the atmosphere. They are made from agricultural waste and are a replacement for fossil fuels, and can be used to heat boilers in manufacturing plants, and also have applications in developing countries.

Biomass briquetting is the densification of loose biomass material to produce compact solid composites of different sizes with the application of pressure. Briquetting of residues takes place with the application of pressure, heat and binding agent on the loose materials to produce the briquettes. They are often used as a development intervention to replace firewood, charcoal, or other solid fuels. In the proper context biomass briquettes can save time, save money, decrease local deforestation rates, and provide income generating opportunity. Briquettes are held together by a binding agent or "binder". This binding material can be any fibrous organic material.

3. COMPONENTS

i. Piston
ii. Cylinder
iii. Double acting pneumatic cylinder
iv. Compresssor
v. Closed die for compacting
vi. Removable cylinder head

i. Piston :-

Piston presses punch the feed material into a die with very high pressure, either mechanically by a reciprocating ram powered by a massive flywheel, or by a hydraulically driven piston. Thereby, the mass is compressed and forms a very dense briquette. Some modern (hydraulically operated) machines apply pressure not only in longitudinal but also in radial direction.

ii. Cylinder :-

Cylinders are used in the majority of applications to convert fluid energy into straight line motion. For this reason, they are often called linear actuators. Cylinders are manufactured in a variety of diameters, stroke lengths, and mounting styles. They may be classified, according to construction, into four types: tie-rod, threaded, welded, and flanged. Cylinders are also made using retaining rings.

Area = $\pi D^2 / 4$ or Area = .7854 x D2

When calculating force developed on the return stroke, pressure does not act on the rod area of the piston, therefore the rod area must be subtracted from the total piston area.

iii. Double acting pneumatic cylinder :-

In a double acting cylinder, air pressure is applied alternately to the relative surface of the piston, producing a propelling force and a retracting force (Fig. 6). As the effective area of the piston is small, the thrust produced during retraction is relatively weak. The impeccable tubes of double acting cylinders are usually made of steel. The working surfaces are also polished and coated with chromium to reduce friction.

Used when equal displacement is needed on both sides of the piston, or when it is mechanically advantageous to couple a load to each end. The extra end can be used to mount cams for operating limit switches, etc.

Pneumatic control systems are widely used in our society, especially in the industrial sectors
for the driving of automatic machines. Pneumatic systems have a lot of advantages.

a. High effectiveness
b. High durability and reliability
c. Simple design
d. Safety
e. Easy selection of speed and pressure
f. Economical
g. Environmental friendly

iv. Compresssor :-

A compressor can compress air to the required pressures. It can convert the mechanical energy from motors and engines into the potential energy in compressed air. A single central compressor can supply various pneumatic components with compressed air, which is transported through pipes from the cylinder to the pneumatic components. Compressors can be divided into two classes: reciprocatory and rotary.

4. DESIGN AND DRAWING

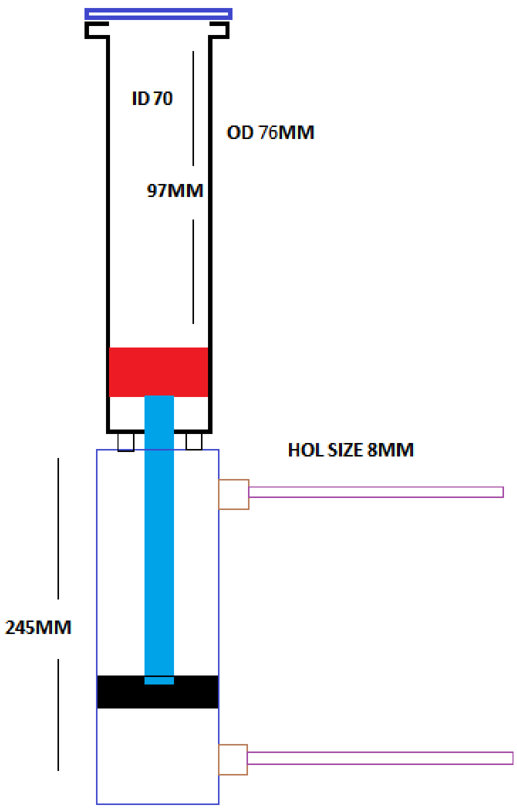
Design of machine element and material selection

Properties of mild steel :-
Ultimate strength = 400MPa
Yield strength (σ_y) a. tensional = 250MPa
b. shear = 145MPa
Modulus of elasticity (E) = 200GPa
Modulus of rigidity = 77.2GPa
Density (ρ) = 7860kg/m3
Coefficient of thermal expansion = 11.7GPa

$$\sigma_z = \left(\frac{d_2{}^2 - d^2}{d_2{}^2 - d_1{}^2}\right)\frac{d_1{}^2}{d^2}p_1$$

$$\sigma_h = \left(\frac{d_2{}^2 + d^2}{d_2{}^2 - d_1{}^2}\right)\frac{d_1{}^2}{d^2}p_1$$

$$\frac{2}{3}\sigma_y = \frac{1}{3}\sqrt{(\sigma_h - \sigma_r)^2 + (\sigma_r - \sigma_z)^2 + (\sigma_z - \sigma_h)^2}$$



σ_a = axial stress
σ_h = hoop stress
σ_r = radial stress = 0
σ_y = design yield stress
$d = d_1$ = internal diameter =6.985cm
d_2 = external diameter =7.62cm

So,
σ_z = 0.7 KPa
σ_h = 7.9761KPa
σ_y = 5.409KPa
σ_y< 250MPa

Hence, Design is safe.

fig shows proposed CAD model

5. ADVANTAGES

1) The process helps to solve the residual disposal problem.
2) The process assists the reduction of fuel wood and deforestation.
3) It provides additional income to farmers and creates jobs.
4) Briquettes are cheaper than coal, oil or lignite once used cannot be replaced.
5) There is no sulphur in briquettes.
6) There is no fly ash when burning briquettes.
7) Briquettes have a consistent quality, have high burning efficiency, and are ideally sized for complete combustion.
8) Two times longer burning hours compared to hardwood charcoal.
9) Biomass briquettes burn without any smoke during ignition and burning .

6. DISADVANTAGES

1) Tendency of briquettes to loosen when exposed to water or even high humidity weather
2) Undesirable combustion characteristics may observed if composition is improper e.g., poor ignitability ,smoking, etc.

7. REFERENCES

1. Oladeji, J. T. (Theoretical Aspects of Biomass Briquetting: A Review Study) Journal of Energy Technologies and Policy ISSN 2224-3232 (Paper) ISSN 2225-0573 (Online) Vol.5, No.3, 2015

2. Alternative of Conventional Solid Fuels: Renewable Energy from Fields International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869, Volume-2, Issue-7, July 2014

3. Nandinishekhar (popularization of biomass briquettes- a means for sustainable rural development) Asian Journal of management research ISSN 2229 – 3795

4. Manoj Kumar Sharma, GohilPriyank, Nikita Sharma (Biomass Briquette Production: A Propagation of Non-Convention Technology and Future of Pollution Free Thermal Energy Sources) American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-04, Issue-02, pp-44-50

5. Design and Fabrication of low cost Briquetting machine and Estimation of Calorific values of Biomass Briquettes. International Journal of Innovative Research in Science, Engineering and Technology *(An ISO 3297: 2007 Certified Organization)* Vol. 5, Issue 7, July 2016 Copyright to IJIRSET DOI:10.15680/IJIRSET.2016.0507055 12454

6. Clancy, J (2001), barriers to Innovation in Small scale Industries: Case Study for the Briquetting Industry in India. Science Technology Society 6, p 329

7. Ghosh, K.P (2002), Converting Biomass. The Statesman March 5th 2002. http:// search.proquest.com /docview/284145740?accountid=38885 retreived on 29.09.11