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An Approach Towards Green Burning:-"Pellet Stove" – A Review

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Abstract

A pellet stove is a Mechanical *Device which uses burned compressed wood or biomass pellets to create a source of heat for residential* and *industrial spaces. These stoves are electronically sophisticated appliances that offer an environmentally friendly and low-cost heating option. It consists of wood chips, waste of nuts, grasses, and lumber yard waste. Pellet stoves provide heat with much less pollution during combustion. Pellet stove includes a chamber with forced draft fan which provides excess combustion air which is powered by external rechargeable battery. The following review paper describes the basics of the Pellet stove. Also in this paper, some of the research work done in the direction of green burning is briefly covered. Also the important concepts related to the Pellet stove are covered.*

Keywords- *Environmentally friendly, forced draft fan, external rechargeable battery, compressed wood, biomass pellets, combustion chamber, gasification process, Pyrolsis zone.*

I. INTRODUCTION

A pellet stove is a stove that burns compressed wood or biomass pellets to create a source of heat for residential and sometimes industrial spaces. By slowly feeding fuel into a (burn-pot)combustion chamber, the combustion of the charge is carried out. The combusiton chamber is considered as an area where a constant flame is developed. Most importantly, in such a stove, it requires little or no physical adjustments for developing such a flame.

1.1 Classification of Pellet Stove

The classification of pellet stove is enumerated as under –

- **According to the mobility of stove.**

1. Fixed Type - A fixed type stove was specially designed for heating purpose. They are heavy in weight ang large size. Its capacity is more than other types. These stoves are fixed to some particular place like wall. They are also called as insert type stove. Now-a days these type of stoves are also used as a heating unit for boilers and furnaces.

Figure 1. Photograph of a Fixed Type Pellet Stove

2. Portable Type – Such a stove is a cooking stove specially designed to be portable and lightweight. Its main application is for domestic purpose, camping or picnicking, or for use in remote locations where an easily transportable means of cooking or heating is needed. Portable stoves can be used in diverse situations, such as for outdoor food service and catering and in field hospitals.

Figure 2. Photograph of a Portable Type Pellet Stove

- **According to the draught system.**

Draught means pressure difference required to maintain flow of air and exhaust gases through the stove. On the basis of draught system, the pellet stoves are classified as follows.

1. Natural Draught - Natural draught is produced by the pressure difference without applying any external force. Generally, Natural draught is obtained by the use of chimney. Chimney produce draught which required to force air and gases through the furnace.
2. Artificial Draught - Artificial draught is produced by the mechanical devices. It has also two types,
   a. **Forced draught:-** In this type, pressure is maintained above the atmospheric pressure. In this system blower/fan is installed near the combustion chamber to provide the air.
   b. **Induced draught:-** In this type, pressure is maintained below the atmospheric pressure. In this system blower/fan is installed near the chimney or end of combustion chamber.

- **According to the type of pellet used.**

1. Wood Pellet - The main ingredients is wood. The wood is considered to be the most common fuel for pellet stoves. Wood pellets are available in standard or premium grade, and are sold nationwide. They are an excellent source of home heating that is becoming increasingly popular, since heating with wood pellets is cheaper than using gas, oil, or electricity.

2. Grass Pellet - Such pellets have high ash content. Strides are being made towards using grass as fuel for home heating and other applications. There are many types of grass that have good potential, including switch grass, reed canary grass, miscanthus, and several varieties of straw grass. The advantages that grass pellets would hold over other pellets are: virtually unlimited resource, lower costs, heat generation, etc.
3. Corn Pellet - A new type of fuel for pellet stoves, corn pellets offer the same cost-effective heating solutions as wood pellet stoves, with increased availability of fuel. The major disadvantage of using corn pellets to heat the home is that we need to invest in a pellet stove that's designed specifically for corn. It has been observed that, the corn pellet stove can handle excessive ash compared to wood pellet types.

II. CONSTRUCTION AND WORKING OF PELLET STOVE

As compared to the other stoves available in market in the present times, the construction of the pellet stove is quite simple and is easy to operate. The main components of a pellet stove are Combustion chamber, Fan, Insulator, Power supply, Casing, Grate. The Figure 3. Shows the basic components of a pellet stove.

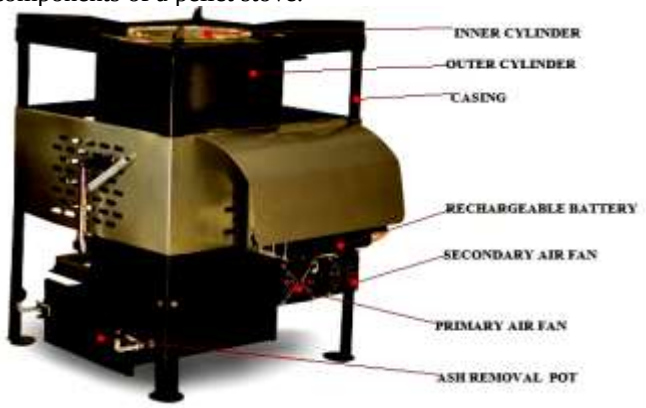

Figure 3. Main components of a Pellet Stove

Working - The pellets are filled in combustion chamber to within 2 cm of the secondary air supply. Then pellets are ignited at the top zone with a match and allowed to burn for a minute or so. When a stable flame is established all around then using the power supply or rechargeable battery, fans are operated and primary air is supplied to the combustion chamber. Primary air is used for "gasification process" of pellets.

Combustion process is done in four zones.

1. Ungratified pellets: - This is the zone where the unburnt pellets are placed. It is above the grate plate in combustion chamber.
2. Pyrolysis zone: - Pyrolysis is a thermo chemical decomposition of organic material at elevated temperatures without the participation of oxygen. The pyrolysis gas is forming in this zone due to the decomposition of pellets.
3. Intermediate zone: - This is the zone, in which the formed pyrolysis gas goes to the flaming zone.
4. Flaming zone: - In the flaming zone, gas is burnt with the help of secondary air.

Then the secondary air is supplied to the top of the combustion chamber with the help of the fan.

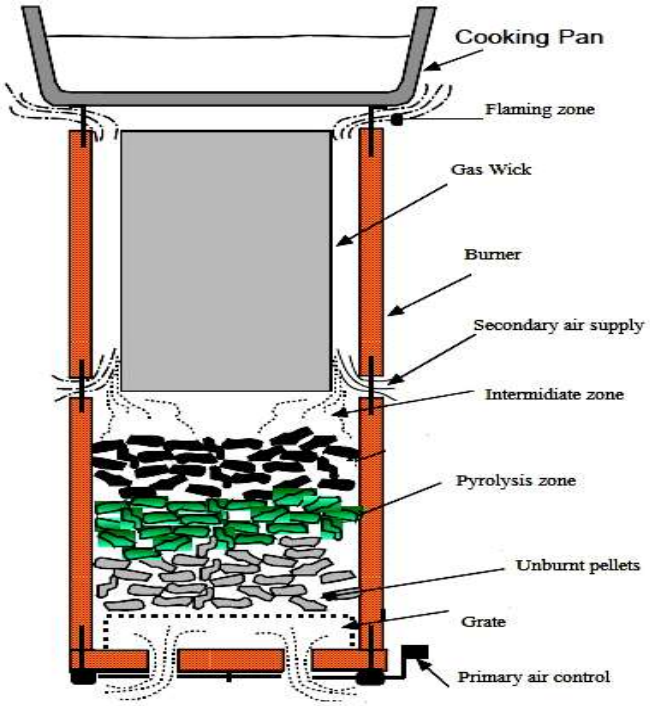

Figure 4. Working of a Pellet Stove

III. LITERATURE REVIEW

3.1 Guofeng Shen, Siye Wei, Yanyan Zhang, et.al, "Emission of oxygenated polycyclic aromatic hydrocarbons from biomass pellet burning in a modern burner for cooking in China". [1]

In the following paper, the authors have worked on the development of Biomass pellets widely used in the world, including China. In this study, emission factors of oPAHs (EFoPAHs) were measured for two types of pellets made from corn straw and pine wood, respectively. Two combustion modes with (mode II) and without (mode I) secondary side air supply in a modern pellet burner were investigated. For the purpose of comparison, EFoPAHs for raw fuels combusted in a traditional cooking stove were also measured. However, the difference between raw biomass fuels and the pellets burned in mode II was not statistically significant. Taking both the increased thermal efficiencies and decreased EFs into consideration, substantial reduction in oPAH emission can be expected if the biomass pellets can be extensively used by rural residents.

3.2 Gireesh Shrimali, Xander Slaski, et.al, "Improved stoves in India: A study of sustainable business models". [2]

In the following paper, the authors have focussed on the use of improving the commercial value for the pellet stoves. Burning of biomass for cooking is associated with health problems and climate change impacts. Many previous efforts to disseminate improved stoves – primarily by governments and NGOs – have not been

successful. Based on interviews with 12 organizations selling improved biomass stoves, the authors concluded to assess the results to date and future prospects of commercial stove operations in India. Specifically, they observed that the companies considered the six elements of their respective business models: design, customers targeted, financing, marketing, channel strategy, and organizational characteristics. And in this paper, the authors have tried to work on these six influencing factors.

3.3 S. Varunkumar, N.K.S. Rajan, H.S. Mukunda, "Experimental and computational studies on a gasifier based stove". [3]

The work reported here is concerned with a detailed thermo chemical evaluation of the flaming mode behaviour of a gasifier based stove. Determination of the gas composition over the fuel bed, surface and gas temperatures in the gasification process constitute principal experimental features. A simple atomic balance for the gasification reaction combined with the gas composition from the experiments is used to determine the CH4 equivalent of higher hydrocarbons and the gasification efficiency.

3.4 E. Granada, D. Patino, et. al, "Available exhaust gas power in different configurations in a pellet stove plant". [4]

With a view to find the best configuration for a small cogeneration system based on the pellet combustion process, exergetic analysis was applied to a small pellet stove. The evaluation focuses on fume exergetic content for power generation purposes. Preheated air, secondary air, fume recirculation and basis configurations were studied. Global exergetic calculation was developed at these configurations based on experimental correlations of energy and emissions. The influences of the pellet feeding rate, excess air, secondary air and fume recirculation were studied.

3.5 Shankar B. Kausley, Aniruddha B. Pandit, "Modelling of solid fuel stoves". [5]

This work presents a detailed theoretical study of solid fuel combustion in a domestic stove (make Harsha, RRL, Bhubaneswar, India). In this work different steady state as well as unsteady state combustion models have been formulated, which include the description of all the chemical and physical processes taking place during the solid fuel combustion inside the stove. Steady state models involve the calculation of effective maximum flame temperature, suction of combustion air created by hot flue gases inside the stove and the propagation of ignition front inside the stove.

IV. ADVANTAGES AND LIMITATIONS OF PELLET STOVE

4.1 ADVANTAGES

- **Clean burning, cost-efficient heating for your home.**
- **No hassle** - Among the many wood-burning stoves available, pellet stoves are the easiest to operate. Only need to load these stoves with wood pellets just once every day or two—and loading the pellets is a simple matter of pulling out the hopper and pouring the pellets in.
- **Smoke free**: Pellet stoves do not produce smoke. This gives freedom from the worries about "smoking out" the gases from the room, or dealing with the subsequent dry air and unpleasant smells.
- **Heat safe**: With a pellet stove, there's virtually no external heat while it's operating. You can place a pellet stove as close as one inch away from a wall, and it will pose no fire hazard. It's the ideal heating choice for households with children and pets.
- **Multi fuel** – The multi fuels can be used in the pellet stove. Example – wood pellet, corn pellet, grass pellet, etc.
- **Fuel availability** - Fuel is easily available in both rural and urban locations.
- **Environmental and cost -** Wood pellets used in pellet stoves are tightly condensed, which makes burning them a low-moisture, highly efficient process. There are less harmful gases released into the air through wood pellet burning than with regular wood-burning stoves. In addition, wood pellets are not a primary product of the forestry industry. Rather, they are a byproduct made with recycled wood from sawmills—usually formed from compacted sawdust and wood shavings, or the unused tops of trees that are cut down for logging. This gives an advantage of getting the wood pellets at cheaper rates.

4.2 LIMITATIONS

- **Electricity** - While pellet stoves primarily burn fuel, they have internal components that need electricity to operate—though some models come with battery packs. In some of the models. We require the electricity to run the fans.
- **Clinking** - Silica (or sand) in the fuel, along with other impurities, can cause clinkering. Clinkering is a function of the fuel, (not the stove), but adversely affects the performance of the stove by blocking off the air holes in the grate.
- **Ash** - The frequency of removal of the ash and maintenance performed on the stove is directly proportional to the ash content of the fuel.
- **Fuel feed rate** - Different brands of pellets will feed at varying rates due to their size and density. This may require a slight adjustment from the factory setting by adjusting the damper rod "in" or "out" as needed.

CONCLUSION

Finally from these review research paper, it can be concluded that the pellet stoves can prove to be a useful means for efficient burning of eco friendly fuels. Also the environmental imbalance created by the burning of some conventional fuels can be reduced to a great extent by increasing the use of pellet stoves. Such stoves can be used efficiently both at household and industry purposes. All the research work carried out in the direction of pellet stoves and burning of pellets proves that the pellet stoves are eco friendly. However, still much work can be done in order to make more efficient pellet stoves. And finally a new means in the path of efficient cooking and energy conservation can be achieved which is the utmost need in the present times.

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