

Design and Fabrication of Pellet Stove

Kunjan Patel¹ Hardik Rathod² Prof. Dharmendra Sapariya³

^{1,2}UG Student, Assistant Professor

³Department of Mechanical Engineering

^{4,5,6,7}Indus Institute of Technology and Engineering, Ahmedabad, Gujarat, India

Abstract:- A Pellet stove is Mechanical Device which uses compressed wood or biomass pellets to create a source of heat for residential and industrial spaces [6]. These stoves are electronically sophisticated appliances that offer an environmentally friendly and low-cost heating option. Its Fuel consists of wood chips, waste of nuts, grasses, and lumber yard waste. The Pellets which are filled in the combustion chamber is then ignited [3]. Pellets are heavily compressed, so they're dense and low in moisture, creating a hotter flame. The combustion chamber serves as the carburettor for the stove, mixing the air and fuel to create combustion. The ashes from the burnt pellets are captured in an ash pot, which needs to be cleaned periodically. Wood pellet stoves are generally small, and the bags of pellets are about the size of a mulch bag, making them easy to store. They're also easy to operate; they only require loading pellets and igniting the flame. Because the fire is contained in a heat box inside the unit, there is a minimum of smoke, which lessens the smell in your home and prevents the outside of the unit from heating up. Pellets create considerably less ash than firewood [5], giving off less creosote, a flammable by product of combustion that can build up and cause chimney fires.

Keywords: Eco friendly fuel, low-cost, natural process

INTRODUCTION:

Energy is the key input for socio-economic development of any Nation. The fast industrialization and rapid urbanization have generated a high demand of energy in all forms i.e. thermal, mechanical and electrical. To meet this ever-increasing demand, fossil fuels such as coal, oil and natural gas have been overexploited in an unsustainable manner. The overexploitations of fossil fuels have been posing serious environmental problems such as global warming and climate change [4]. We are more dependent on imports of petroleum. To concerns over health, climate change and energy security so the energy crisis of the World to look for less expensive and more efficient. To solve mentions problem and efficient cooking the Pellet stove is best option we had. By provide efficient cooking stoves to rural areas an effort to reduce air pollution and conservation of other energy sources. The Main reason behind less pollutant emission by Pellet Stove is Wood Pellet which containing less Carbon [4]. Our Objective is to produce residential Multi burner Pellet Stove which can replace Domestic home appliances as Gas Burner. We will try to optimize cost effective and high efficient cooking by using Multi burner Pellet Stove. Pellet stoves could also significantly reduce greenhouse gas emissions and zero percentage CO₂ emission [5]. Such a program would avoid 17 percent of the premature deaths and disability from respiratory infections,

heart disease, and bronchitis that would have occurred in 2020, saving some 55.5 million years of healthy life that would otherwise be lost from air pollution exposure, the study found[4].

WORKING PRINCIPLE:

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, 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. Then the secondary air is supplied to the top of the combustion chamber with the help of the fan [7].

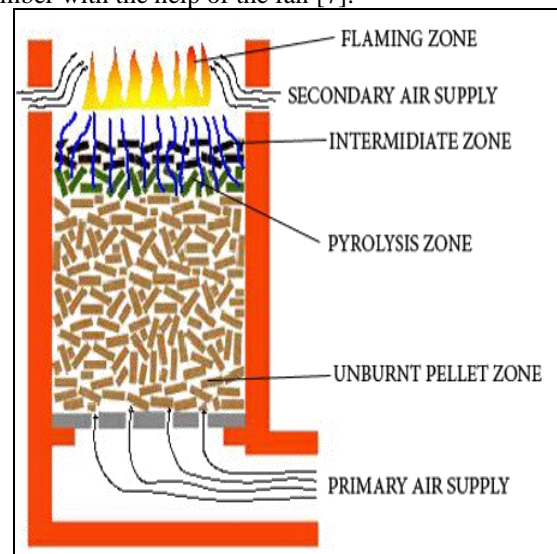


FIG 1:- COMBUSTION PROCESS

Combustion process is done in four zones.

- **Ungratified pellets:** - This is the zone where the unburnt pellets are placed. It is above the grate plate in combustion chamber.
- **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.
- **Intermediate zone:** - This is the zone, in which the formed pyrolysis gas goes to the flaming zone.

- **Flaming zone:** - In the flaming zone, gas is burnt with the help of secondary air.

LITRETURE REVIEW:

Larry Hepper, Carl Williamson show a pellet stove is disclosed comprising a reverse flow heated air pathway defined by stove sections. In an illustrated embodiment, the space between upper and lower stove sections is open to provide a heating or oven area. The stove can be readily disassembled in part for easy portability [8].

Gary Wisener Says A pellet stove utilizing gravity feed and natural draft more effectively and efficiently burns pellet fuel while producing less air pollution and ash. In one embodiment, the pellet stove has a primary combustion area comprising a burn unit removably disposed in the vent tube, a feed tube defining a fuel chamber above the burn unit and a secondary combustion area, comprising a burn box defining a secondary burn chamber, below the burn unit. A control mechanism controls the air flow to regulate the heat generated by the pellet stove [1].

MATERIAL SELECTION:

➤ **Insulating Material**

For the insulating purpose different material like Cerawool, Ceramics are there. As we know cerawool is good insulator but due to cost of cerawool is high and we have to provide some material to protect cerawool against direct contact with heat, in that case pellets are over burnt due to natural conduction of material. To eliminate above mentioned problem we select ceramic as insulating Material.

➤ **Grate**

For the grate material we can select M.S. and Cast Iron. Due to the advantages of Cast Iron (C.I.) like easily machinability, low cost, low weight so we select Cast Iron as grate material.

➤ **Supporting structure**

For supporting the structure and proving good strength, ductile material, easily available we select the Mild steel as outer body.

COMPARISON OF ENERGY RATING OF FUELS:

This is a breakdown of what the most common forms of energy rating.

Wood Pellets	19,444 kJ/kg
Shelled Corn	16,888 kJ/kg
Natural Gas	10,550 kJ/kg
Propane	25,678 kJ/liter
Electricity-Resistance	3,600 kJ/kWh
Bituminous Coal	28,133 kJ/kg
Anthracite Coal	32,822 kJ/kg
Seasoned Firewood	16,440 kJ/kg
Fuel Oil	38,518 kJ/liter
Kerosene	37,671 kJ/liter

CALCULATION

CALCULATION FOR 1.75 KG STOVE :

Minimum air / kg of fuel	6 Kg/Kg of fuel
Volume	$2.5 \times 10^{-3} \text{ m}^3$
Diameter of pellet stove	152.4 mm
Height of pellet stove	137 mm
Stoichiometric air required	10.5 kg
PRIMARY FAN	CFM - 7.50
	Voltage - 12 V

SECONDARY FAN	Ampere	- 0.14 A
	Dimension	- 40x40x20 mm ³
	CFM	- 7.50
	Voltage	- 12 V
	Ampere	- 0.14 A
	Dimension	- 60x60x15 mm ³

3D DESIGN:

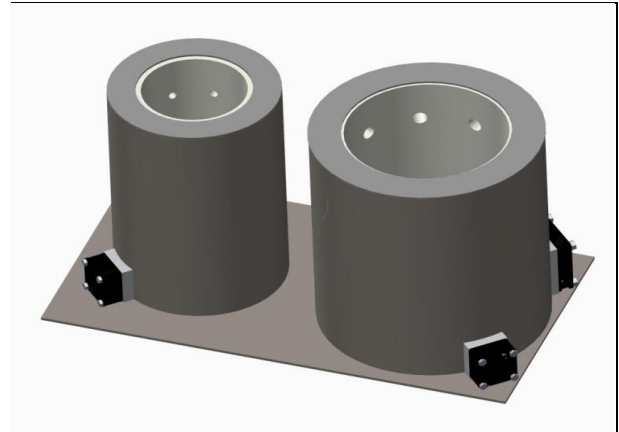


FIG 2:- PELLEST STOVE



FIG 3:- ASSEMBLY DRAWING OF PELLEST STOVE

CONCLUSION:-

It is concluded that, the wood pellet stove has been started and operated indoors without creating pollution with high grade of thermal energy. The wood pellet stove is eco-friendly, which emits less carbon dioxide compared to other fuel. We are introducing multiple burner pellet stove which is useful for domestic purpose such as cooking, heating etc. Our stove has multi burner which has different configuration and dimension so we can use it lower and higher capacity as per requirement. However, we believe that there is still much work to be done in optimizing the stove for various fuels, determining the effect of moisture, adapting it to various cooking situations and developing other uses. For that reason we are publishing our preliminary results here and hope that others will help adapt these principles to improve world cooking and energy conservation.

REFERENCES:

- [1] Gravity feed natural draft pellet stove US20070186920A1 Publication date: - DATE: - 16 AUG 2007 Gary Wisener
- [2] <https://patents.google.com/patent/US8020547?q=pellet+stove> (PELLET STOVE)
- [3] Effect of wood fuel on the emissions from a top-feed pellet stove O Sippula, K Hytönen, J Tissari, T Raunemaa Energy Fuels 2007, Vol-2, 1151-1160 Publication Date: February 1, 2007
- [4] Emission from realistic utilization of wood pellet stove Energy Volume 68, 15-04-2014, Pages 644-650G Toscano, D Duca, A Amato, A Pizzi Publication Date: February 20, 2014
- [5] High efficiency wood pellet stove-US5873356A US patent Energy Fuels 2011, Vol- 11, 5015-5021 JL Vossler, WK Tomooka Publication Date: 23-02-1999
- [6] Mobile pellet stove with thermal barrier and ventilated firepot US5429110A US patent TM Burke, LT Burke Publication Date: 07-04-1995
- [7] Pellet stove with enhanced air circulation efficiency- US5123360A US patent Environ. Sci. Technol 2016, Vol-10, 369-374 TM Burke, WL Burke Publication Date: 23-06-1992
- [8] Pellet stove Fuel Volume 211, 1-01-2018, Pages 269-277 L Hepper, C Williamson Publication Date: 20-09-2011
- [9] Natural draft automatic feed pellet stove Fuel Processing Technology Volume 174, 1 June 2018, Pages 104-117 MA Jarvi, B. Mechman, K. Blackhard
- [10] Particle emissions from pellets stoves and modern and old-type wood stoves Biomass and Bioenergy Vol.-35, Issue 8, August 2011, Pages 3648-3655 LS Bäfver, B Leckner, C Tullin, M Berntsen