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PINE NEEDLES BIOMASS- A POTENTIAL FUEL

Er. Pankaj Verma [1]
[1] *Electrical Engineering, TR Abhilashi Memorial Institute of Engineering & Technology Tanda Mandi H.P-INDIA*

Er. Kushal Sharma [2]
[2] *ME Scholar, GGS College of Modern Technology Kharar Panjab-INDIA*

Er. Abhay Mahajan[3]
[3] *Electrical Engineering, Greenhills Engineering College. Kumarhatti Solan H.P-INDIA*

ABSTRACT
India is a country having ample forest wealth contains diverse forest spices. The existing plantation dominates pine trees cover in middle and lower Himalayan regions. Throughout total forest cover 7.62-million-hectare region is under pine forest. The state has identified rise in forest area by .71 % as 15100 in 2017 from 14696 in 2015. With increase in pine forest density the forest fire accidents also increases. There are different reasons count for this as the dry pine needle on the floor of the forest catches fire easily in summers and some time the local villagers set forest under fire to clean the forest floor so that grass for their cattle's can easily grow. It is found that the dry pine needles contains high volatile matter and catches fire easily. This property can make it a batter fuel by suitable technological interventions. This paper establishes an approach to produce fuel from dry pine needles and use it as potential fuel.

KEYWORDS: *Pine needles; Drying; Carbonisation; Binding materials;*

1. INTRODUCTION

An alternative energy resource establishment is the usage of biomass pine needle as an alternative energy resource in which the pine needles subjected to pressure and produced fuel will be in the form of briquettes and pallets. The process of palletising involves densification of biomass to achieve high energy density and low moisture contents. As per study the allowed value for the moisture content is 8-12%. The other mechanical properties includes compressive strength, tensile strength, bending and many more.

Due to the carbon content present in the pine needles they can be used as a biomass by increasing the density. The biomass can either be directly utilised for making briquettes or processed to increase the carbon content of dried biomass. The general process identified is carbonisation. In this process, the material is burnt in absence of oxygen in the carbonizor. The resulted mixture is mixed with binder to make it adhesive hole and turned it into cakes. The properties of developed briquettes then be analysed with standard procedures [1]. The produced charcoal briquettes can also used as a replacement of wood and kerosene as cooking fuel in households and can benefit economics of rural areas.

2. BRIQUETTING PROCESS

The Process involves various stages includes char formation and briquette formation. Char formation is a series of processes starting from collection of biomass from forest floor to carbonisation and crushing. Crushing process helps to shorten the burned needles of pine residue. The char size is also important factor which effects the compaction properties of biomass material. Binder's material help bio char for compaction but their proportion selection is critical [2]. More binders can affect the physical property e.g less binder material can affect the physical strength of briquette and more material can affect the burning rate and increase ash content[1]. Type of binder can also affect the briquetting process and a suitable binder or different binders in suitable proportion will result a good product.

2.1 BIOMASS COLLECTION

Pine needles can be collected from pine forest floor and sorted. The twigs and tree branches must be eliminated during sorting process. The main thing to noticed that the needles should not be green or fresh. The pine needles Should be dried for 1-2 days in sunshine open space so that all the moisture content available in the pine needle will be removed.

2.2 PYROLYSIS

The process of converting or treating low carbon biomass into high carbon fuel by burning it in absence of oxygen is called as pyrolysis. The process is also known as carbonisation and the drum like structure used for this is called carbonizer. In carbonizer the pine needles allow to burn in open air for 1-2 minutes so the catches fire and after that the container must be sealed. After some time the needle get partially burned and the pine biomass is converted in to pine char. The drum structure, quantity of biomass affects the time of conversion from biomass to pine char as shown in Figure 1.The produced material after carbonisation is known as Biochar or pine char in case of pine needles.

Figure 1 Carbonizer

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2.3 BINDERS

Binders as the name implies the material which help pine char particle to hold themselves. Binders may be different materials but should be suitably selected so that these could not affects the burning property of fuel. Clay, Cow dung re generally used binders but their proportion is a matter of research. Now a days resin of different plant can be used as binder. In present case investigator utilize resin of Grewia Optevia plant resin (lignin) as binder material and investigate its characteristics. Total three binders in different proportion has been utilised in briquetting process as shown in Table 1.

TABLE1. SAMPLE FORMATION OF BRIQUITTES

No. of Sample	Quantity of Char (% age By Volume)	Type of Binder	Quantity of Binder (% age By Volume)	Weight of Briquettes (in grams)
3	80	Clay	20	**90**
3	80	Cow dung	20	**110**
3	80	Grewia optiva (Plant Resin)	20	**80**
3	60	Clay	40	**85**
3	60	Cow dung	40	**100**

2.4 COMPACTION PROCESS

A Briquettes is a block of coal dust or binder that are compressed with other biomass combustible (such as charcoal, sawdust, wood chips, pine needles etc). All combustible material utilised contains low energy density for making it as fuel therefore, compaction of fuel is required. The process enhance the density of biomass to be used as high density fuel. The powdered biomass is now converted into briquettes or pallets by compaction process [3]. The arrangement of screw press mechanism is shown in Figure 2 with produced product. The size and shape of briquette affects its burning rate and physical strength. The cylindrical shape provides good mechanical strength and vents in briquette structure allow air to flow for good combustion [4]. Good physical strength help to transport the produced fuel from one place to another and increases its economic viability.

Figure 2 Compaction Machine and Briquette

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3. TESTING OF BRIQUETTES

Testing involves presence of moisture and volatile matter present in the briquette produced. Different test are required to perform to predict the characteristics of the produced fuel. The proximate analysis is performed on pine char, mixtures of pine char-cow dung and pine char-clay and moisture content, volatile matter, fixed carbon and ash content of various samples has calculated [5].

3.1 MOISTURE CONTENT

Owing to its nature and origin, coal is always associated with moisture. Air dried moisture is determined by heating a known amount of coal (air dried) at 105-110 degree Celsius in an electric hot oven for about one hour. The %age moisture content is determined by using formula:

$$\text{Percentage of Moisture} = \frac{\text{Loss in weight}}{\text{Weight of coal taken}} \times 100$$

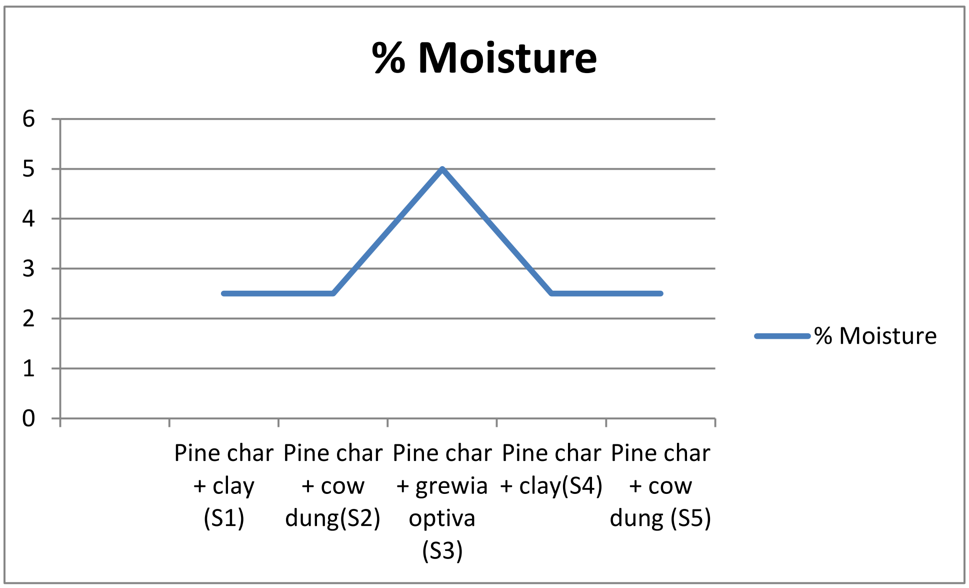

Figure 3 Determined Moisture Content in Briquette

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Thus, by considering these values of the moisture content, it is clear that the combination of the pine char and clay is having the least percentage of the moisture content. It means that the briquette formed with this mixture burns more efficiently. The **Pine char and Grewia Optiva(Resin)** combination is having the highest amount of the moisture content as shown in Figure 3. More is the moisture content; more difficulties come across for burning the briquette. Thus, the pine char and clay combination and char with cow dung have similar results.

3.2 VOLATILE MATTER

The volatile matter in each of the sample is calculated by firstly heating the sample in a furnace and then calculating the loss in weight in each of the samples and after that subtracting the moisture content of the sample taken in the consideration. It is determine by heating a known amount of moisture free coal in a covered platinum crucible at 950$\pm$ 20 degree celcius. The volatile matter can be determined with formula:

$$\%\text{age of Volatile Matter} = \frac{\text{Loss in weight due to removal of volatile matter}}{\text{weight of coal sample}} \times 100$$

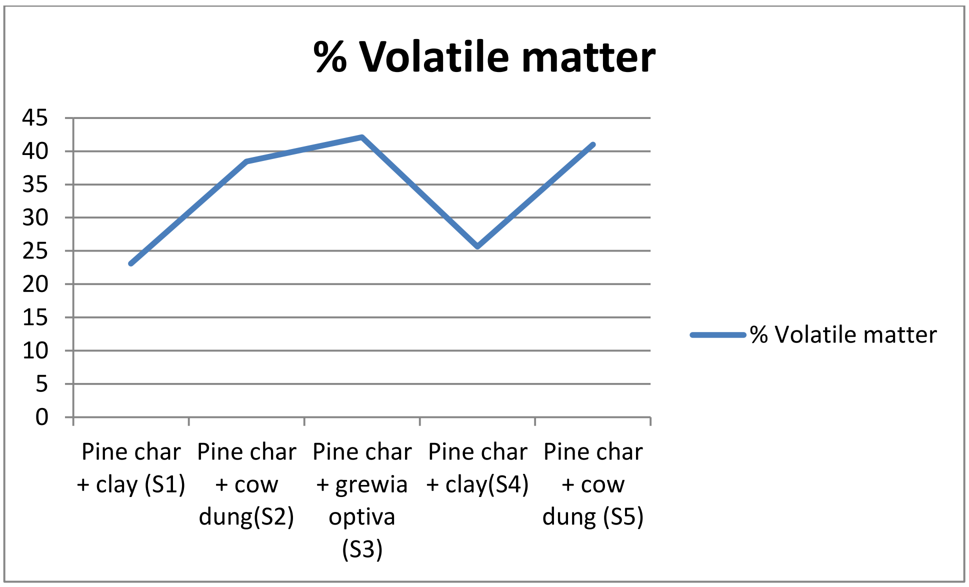

FIGURE 4 Determined Volatile Matter In Briquette

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The volatile matter should be more for efficient burning of the briquette or the fuel. It is clear from the values given in the above Figure 4. That the mixture of the pine char and grewia optiva is the best among the all samples for the briquette production because it is having the most volatile matter among the three samples considered. The pine char sample comes out to be having the least volatile matter, thus having least efficient burning. The biomass and their generations according to the technology and efficiency has been discussed in various researches [6].

3.3 CARBON AND ASH CONTENT

For calculating the carbon and the ash content in each of the sample, the previously furnace heated sample is heated on the burner and the residue weight is calculated. It gives the ash content. The loss in the weight will give the value of the fixed carbon in the sample. The fixed carbon in the sample is given by formula as below. The ash content and moisture content of the substance should be low and volatile matter and carbon content should be appreciably high. The determined values for various sample is as shown in Figure 5.

Percentage of fixed carbon = 100 - [% of moisture + % of volatile + % of ash]

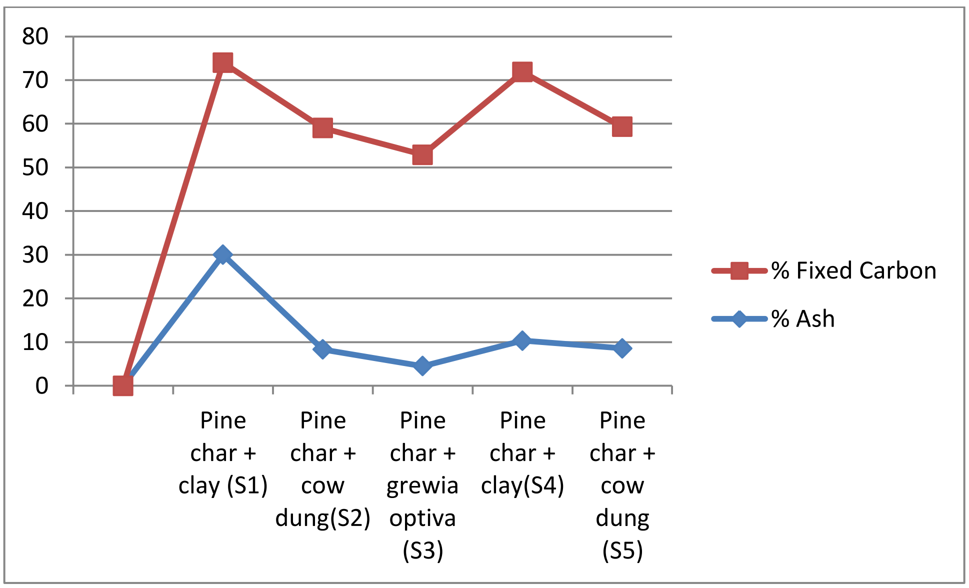

Figure 5 Determined Fixed Carbon in Briquette

4. RESULTS AND DISCUSSIONS

The ash content should be minimum for a fuel because higher ash content means higher non-combustible content which does not let the fuel burn efficiently. It is clear from the above study that the ash content is least for the pine char and Grewia Optiva combination. The ash content is the most for the pine char and clay sample as well as the fixed carbon content. The ash content of the sample having clay combination with pine char and other is more than every other sample. The fixed carbon content comes out to be approximately equal to that of the pine char and clay sample in higher concentration as sample S4 also. The present study shows the pine char and the clay mixture and pine char with Grevia Optevia resin samples contains good results among all the samples according to the ash content and fix carbon contents. For selecting the product as a fuel other physical and chemical test can be done because physical characteristics are also important for selecting a substance to use as fuel.

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