Pine Needles A Source Of Energy For Himalayan Region

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Abstract: Pine trees cover large portions of the Himalayan region and are considered a hazard to cultivation and agriculture as well as the environment. This is because during the summer season, dry pine needles fall from the trees and cover the forest floor. Not only is this detrimental to cultivation, and the growth of grass needed as fodder for livestock, this is also a serious cause of uncontrolled frequent forest fires during the dry months. The focus of this study is to research alternate uses of these dry pine needles, including energy generation, which would result in an economic boost to the region. It would also greatly reduce the risk of forest fires, and therefore be of value from an environmental point of view

Index Terms: Pine Needle, Himalayan Region, Forest Fire, Economic Boost, Environment, Forest Floor

1 INTRODUCTION

The Hindu-Kush-Himalaya (HKH) mountain chain extends over 3,500 km across the countries of Afghanistan, Pakistan, China, India, Nepal, Bhutan, Bangladesh and Myanmar, covering an area of about 43 lakh km2. Clubbed with stretches in western Nepal and Himachal Pradesh, pine forests cover about 1.5 million hectares. The Himalayan Subtropical Pine Forests are the largest in the Indo-Pacific region. They stretch throughout most of the 3,000-km length of the world's youngest and highest mountain range. The Himalayan subtropical pine forests are a large subtropical coniferous forest ecoregi on covering portions of Bhutan, India, Nepal, and Pakistan. They cover almost 76,20000Hectares The Indian part of the Himalayas covers an area about 5 lakh km2 (about 16.2% of country's total geographical area) and forms the northern boundary of the country. The Indian Himalayan Region (IHR) is spread across 10 states (administrative regions) namely, Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Mizoram, Tripura, and the hill regions of 2 states viz. Assam and West Bengal - comprising about 95 districts of the country. In the summer season, forest fires are common in these areas as pine needles, essentially needle shaped leaves which keep falling off trees from the middle of March till the onset of the rains in July, are highly inflammable. Even a half-burnt cigarette carelessly thrown by a villager or tourist can cause fires that gut large forest areas. These fires destroy the local ecology, damaging the fertile top layer of the soil and destroy grazing grounds for cattle. Due to the low density and low heating values of pine needles it is not practical to use them for heating and cooking purposes. While they do have a limited use as bedding for livestock, the quantities used for this by local villagers are small, leaving most of the dry fallen needles lying on the forest floor through the summer season.

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If a practical use could be found for them, not only would it mean a significant reduction in forest fires, but this would also provide energy as well as livelihood for the local communities. Therefore, the implementation of technology which would facilitate the use of dry pine needles as raw material for energy production in the region may be seen as a necessity for sustainable development here. The world energy requirements are growing according to the Energy Information Administration(EID) which also predicts that the world energy demand will continue to increase at a rapid rate until 2025.The majority of this increase is due to increasing economic growth in Asia including India and China (USDOE,2005).The other reason for this is Industrialization & Economic growth. Most of the Himalayan region suffers from seasonal power shortages and the hilly terrain with poor transmission and infrastructure mean a very unreliable supply of electricity in the area. People frequently use kerosene, which is expensive and highly damaging to health and the environment, as a cooking and backup lighting source. Pine needles have tremendous energy and there is a need to harness this. Using pine needles we can generate energy in several ways – for instance, we can directly use these needles for electricity generation or they may be used with some other binding material as a source of heat. The by-products of pine needle gasification provide quality charcoal for cooking. In this study we are going to explain the different heat generating capacity with pine needle which is useful for the social economic environment friendly development of this region.

2. METHODS

Pine needles which can be collected locally in this region can be used for energy generation purposes, the conversion of low density pine needle into high density pine needle briquettes or by partial combustion of chopped pine needles. Different techniques and methods can be used for both these purposes.

2.3 Fuel Analysis for pine needles

Fuel analysis is done to check the availability of various element in pine needles and also to insure its thermal application

2.3.1 Ultimate Analysis-

The ultimate analysis indicates the various elemental chemical constituents such as Carbon, Hydrogen, Oxygen, Sulphur, etc. It is useful in determining the quantity of air required for combustion and the volume and composition of the combustion gases.

TABLE 1 ultimate Analysis of pine needles

S.N.	parameters	Available %
1	Ash	1.31
2	Carbon	52.60
3	Hydrogen	07.00
4	Oxygen	40.10

2.3.2 Proximate analysis

Proximate analysis indicates the percentage by weight of the Fixed Carbon, Volatiles, Ash, and Moisture Content in coal. The amounts of fixed carbon and volatile combustible matter directly contribute to the heating value of coal. Fixed carbon acts as a main heat generator during burning. High volatile matter content indicates easy ignition of fuel. The ash content is important in the design of the furnace grate, combustion volume, pollution control equipment and ash handling systems of a furnace. The proximate analysis is carried out according to JIS M 8813.

TABLE 2 proximate Analysis of pine needles

S.N.	parameters	Available %
1	Mean moisture content	9.76
2	Mean ash content	4.37
3	Mean volatile matter content	70.03
4	Fixed carbon content	15.83

Calorific value of the pine sample was determined using microprocessor bomb calorimeter and the value is 4795Kcal/Kg

2.1 Gasification Technology

Pine needle (biomass) gasification involves thermo chemical conversion of the carbonaceous material. In the reactor, commonly known as a gasifier, chopped and dried pine needles undergo pyrolysis, oxidation and reduction reactions at high temperatures with a limited supply of air, resulting in a mixture of combustible gases - carbon monoxide, hydrogen and methane. When the dried feedstock gets heated to temperature in the range 200-500^{0}C,pyrolysis of the chopped pine needles takes place, and the volatile combustible matter in the feed stock is released - the by-product of this process is char

Exothermic combustion reaction ,

$$C + O_2 \longrightarrow CO_2 \quad (1)$$

Endothermic Boudouard equilibrium process,

$$C + CO_2 \longrightarrow 2CO \quad (2)$$

Endothermic Heterogeneous water gas shift reaction,

$$C + H_2O_{(g)} \longrightarrow 2CO + H_2 \quad (3)$$

Exothermic hydrogenation gasification ,

$$C + 2H_2 \longrightarrow 2CH_4 \quad (4)$$

2.3 Gasification Process

Different processes are involved in pine needles gasification-

Drying - in this process moisture is removed from the biomass by evaporation. This should ideally take place at a temperature of up to about 160ºC using waste heat from the conversion process.

Pyrolysis- here, volatile gases are released from the dry biomass at temperatures ranging up to about 700ºC. These gases are non-condensable vapours (e.g. methane, carbon-monoxide) and condensable vapours (various tar compounds) and the residuum from this process will be mainly activated carbon.

Reduction- In this process activated carbon reacts with water vapour and carbon dioxide to form combustible gases such as hydrogen and carbon oxide. The reduction (or gasification) process is carried out in the temperature ranging up to about 1100ºC.

Oxidation, where part of the carbon is burned to provide heat for the previously described processes.

2.4 By-products

The by product can be used in the form of briquettes for cooking purposes and other heating applications. In the briquette-making process first the char is mixed with some binding material such as clay and then filled in the shape of briquetting mould (cylindrical and rectangular) then dried them for three or four days in sun light before use.

3 TYPES OF GASIFIER

On the basis of the flow direction of air pine needles in the reactor (gasifier), gasifiersmay be classified as updraught, downdraught and cross- draught gasifiers. In all these kinds of reactors, the pine needles fall downwards by gravity. In an updraught gasifier, the flow of gas and air is upward, in downwards gasification air and gas flow is also downwards and in cross-draught gasifiers, the air and gas flow are horizontal. Besides fixed bed gasification reactors, there are fluidized bed gasifiers which are used for large output power range - fixed bed reactors are used for 5kw to a few MW, where as the fluidized bed design is used in units of a few hundred kilowatts upwards.

4 GAS COOLING AND CLEANING-

The gas generated in reactor is at a high temperature and also carries along some ash, for further utilization of this gas such as running an IC engine. The high temperature of this gas reduces the volumetric efficiency of IC engine, since at this temperature, where the density of gas is low, the mass of gas-air mixture the cylinder can aspirate decreases resulting in a decrease in power output.If the gas carries ash content then there is a possibility of jamming of the moving parts and blockage of small passages. Thus cleaning and cooling of produced gas before use is essential, dust removal can be done by the use of filters, and it is necessary to replace the filters periodically so as to prevent its clogging with ash. In order to get proper cooling and cleaning of the gas more than one these type of systems are used in series.

3 GASIFIER ENGINE SYSTEM

The produced gas is used inside the gasifier system to drive prime mover such as IC engine. This prime mover's mechanical energy can be used for driving a pump or to drive an electric generator to produce electrical energy. The IC

engines are most efficient and least expensive in the range of few KW to few MW.

5 PINE NEEDLES AVAILABILITY AND MANAGEMENT

Pine needles is a very important part of a gasifier based power plant. Two main aspects are quantity estimates of availability of pine needle on a sustainable basis, the second aspect of pine needle supply Pine needle supply can be a very important source of employment generation for the locals. The mode of supply can be serious issue, there are two possibilities one it should be contractual or involving local on daily wages. The cutting of pine needles can be done by manual or by machine. There is a need to take proper care of storing of pine needle if the plant needs to run throughout the year because the availability of pine needles is only during the summer session , the pine needles supply and storage to become a good economic activity for the villagers, they must get good return out of this, as pine needle collection is done by the villagers, and the cost of pine needles collection add a value on electricity generation or decide the cost of electricity, so the villagers are directly associated with decision making related to such issues The total area of Pine Forest in reserve forest in Uttarakhand is about 3.43 Lakh Hectare. These Pine forests in Uttarakhand produces about 20.58 lakhs tones dry biomass (pine needle) annually. Since carriage of pine needle is not easy, hence if we consider the carriage of pine needles from the pine forests which are near to habitation or near the road head than approximately 40% of the biomass can be transported. Hence we can hope to get about 8.23 lakh tones every year. It means in every hectare we are getting 60.5 Kg of pine needles .in total Himalayan region if we just assume that the accessibility is just for 40 % then the total area is 30.48 Lakh Hectare, which will give approximately 1.9 Lakh Tones every year(only in 40% easily accessible region)

6 RESULTS

Due to the large availability of pine needles in the Himalayan region, it can not only produce electricity for its own use but it can also contribute to the national grid system. Using pine needles in electricity generation will not only save the environment, by preventing forest fires, but also contribute to the energy demands of the region. The results are further distributed as follows

6.1 Economical

Due to the free availability of pine needles this type of system requires some initial investment. However, the payback period for such systems is very low because of the high tariff rates of electricity.

6.2 Social

Most of the hilly states suffer from acute negative population growth - due to the lack of job availability in these regions, people are moving to different cities in order to get jobs.

6.3 Enviromental

Pine needles are a major cause of forest fires during the summer.These fires destroy the local ecology, damaging the fertile top layer of the soil and destroy grazing grounds for cattle. By using pine needles, local people will be encouraged to collect them, thus removing them from the forest floor. In this way we will not only generate energy from this biomass, but also help to preserve and save environment.

4 CONCLUSION

The above discussion has attempted to show that there is immense power in pine needles if they are used properly. Pine needle gasification is indeed a very promising technology for decentralized power generation in the Himalayan region due to the wide availability of pine needles. The generation of power is not the only benefit of this technology; it also contributes towards the environment. The result is a two-pronged strategy of development where we can save the environment and the cost for this is itself paid by energy production. While the prospects for this technology are very good, the challenges in implementation are also very high. There are many aspects related to pine needle gasification that must be dealt with in an efficient manner on a community level. This includes waste management, safety issues, load management and mode of plant operation. In conclusion, we feel that this type of technology will provide a social, economic and environment friendly development.

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