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Using Agricultural Residues for Biomass Briquetting and pelletising asa Source of Renewable Energy to replace fossil energy by biomass co-firing to mitigate climate change and address farmer's poverty by enhancing farmer's income

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Abstract

Achievement of long term climate change mitigation objectives will ultimately require a transition from fossil fuel energy to renewable energy. Every year millions of tons of agricultural wastes are generated which are either destroyed by left to decay on their own in fields generating methane (CH4) or burnt inefficiently in loose form by carbon dioxide (CO2)) causing air pollution and global warming as both are potential greenhouse gases. The agricultural residues like rice husk, wheat straw, castor shells, ground nutshell and cotton stalks etc. generated in abundance in state of Gujarat which are either left to decay on their own or burnt in fields to clear fields for next sowing season of crops can be utilized as the potential biomass energy sources to be densified into pellets and briquettes for biomass co-firing as well as replacement of fossil energy and fuels .This renewable biomass energy fuel is beneficial for the environment as it conserves natural resources

as well as generates additional income for farmers whereby instead of spending money on getting rid of these agricultural residues from fields farmers can actually earn handsome amount of money by selling these agricultural residues and farm wastes and also simultaneously contribute to green-house mitigation and climate-change mitigation.

In this paper we examine agricultural residues like rice husk, wheat straw,saw dust, castor shells,ground nutshell and cotton stalks etc generated in abundance in state of Gujarat as the potential biomass energy sources to be densified into pellets and briquettes for biomass co-firing as well as replacement of fossil energy and fuels. We discuss the various advantages, factors that affecting the biomass briquetting and comparison between coal and biomass briquetting. The details of the study were highlighted in this paper.

Keywords- Biomass, Briquetting, Pelleting, Potential, Process, Technologies

Introduction

Concerns regarding the potential global environmental impacts of fossil fuels used in power generation and other energy supplies are increasing worldwide. The primary driver of climate change is the emission of greenhouse gases, including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) that arise from a number of human activities, the primary contributors being deforestation and the burning of fossil fuels for energy generation. Achievement of long term climate change mitigation objectives will ultimately require a transition from fossil fuel energy to renewable and sustainable energy. A number of techniques and methods have been proposed for reducing gaseous emissions of NOx ,SOx and CO2 from fossil fuel combustion and for reducing costs associated with these mitigation techniques. Some of these control methods are, however, expensive and increase the overall production costs.

Biomass Co-Firing : A Potential Option To A Clean Future

One of the key areas of environmental concern globally is power generation in coal power plants. Coal fired power plants account for 41% of global electricity, and the importance of coal to electricity generation worldwide is set to continue with coal fuelling 44% of global electricity in 2030. There is an increasing interest worldwide in generation of energy from biomass, as a carbon neutral alternative to coal. Among the quickest and most cost-effective alternatives for large electric utilities producers is the technique of "Biomass cofiring"

Biomass cofiring refers to the simultaneous combustion of a biomass fuel and a base fuel to produce energy, usually electrical power. "Biomass co-firing" in coal based power plants involves replacing a certain percentage of coal the biomass briquettes/pellets to reduce GHG emissions at source. This technology is emerging as a sustainable model for mitigating environmental degradation due to carbon emissions from large coal based power plants.

The technology has successfully moved from engineering studies to parametric tests to long term demonstrations. As it gains acceptance worldwide, co-firing technology will address many environmental issues facing the world today.

Worldwide, about 40% of electricity is produced using coal. If only 5% of coal energy is replaced by biomass in all coal-fired power plants, this would result in CO2 emission reduction of around 300 Mton CO2/ year.

Co-Firing With Biomass Briquettes/Pellets

Co-firing is the simultaneous combustion of a supplementary fuel with a base fuel. The most common base fuel is coal. Biomass briquettes/pellets are a carbon neutral, renewable fuel source produced using farm residues, left over forest residues and other natural organic stuff, as well as through farming of dedicated energy crops and plants on marginal or wasteland.

Co-firing with biomass briquettes/pellets incorporates environmental, socio-economic and larger strategic advantages including.

- Lower capital costs for power generation.
- Reduced coal usage without major technology and infrastructural changes.
- Highest electrical conversion efficiencies amongst all biomass power technologies.
- Proven model world wide in installations for most fuel combinations and boiler types.
- A clean, renewable fuel for power plants with reduction in GHG emissions and ash content.
- People friendly alternative that improves hygiene, maintains cleanliness and lowers dust generation.
- Ease of compliance with emission norms as compared to solar and wind technologies.

- Greater employment and income generation opportunities to support rural economies.
- Encourages the formation of a biomass commodity market.

Co-firing with biomass briquettes/pellets is, therefore, a long term, sustainable alternative that has the potential to meet the global climate challenge, as well as generate grassroots growth and development for nations.

About Biomass Briquettes/Pellets

Half a kilo of dry plant tissue can produce as much as 1890 kcal of heat which is equivalent to the heat available from a quarter of kilogram of coal.

Biomass is a renewable energy resource derived from numerous sources, such as left over farm residues, left over forest residues and other natural organic stuff, as well as farming of dedicated energy crops and plants. Biomass is the most important fuel worldwide after coal, oil and natural gas.

Biomass is abundantly available on earth in the form of agricultural residues that lie unutilized and can be effectively used for power generation.

Biomass Briquettes/Pellets /Pellets

Biomass briquette is a fuel material that is uniform insize, shape, moisture, density and energy content, produced by drying and compacting different types of biomass. During the production process, biomass is dried in the most efficient way in order to ensure maximum heat generation when it is burned in the boiler.

Biomass Briquettes/Pellets/Pellets Are Carbon Neutral

From a chemical perspective, biomass briquettes/pellets contain carbon in simple or more complex combinations with other chemical elements - oxygen, hydrogen, etc. Carbon is the base element, which can be burned (by oxidizing it) to produce heat energy, which can thereafter be converted into other types of energy -steam, electricity, etc.

From an ecological point of view, biomass briquettes/pellets is an ideal fuel material because it is considered carbon neutral. Using biomass briquettes/pellets/pellets as an energy source creates a

'closed carbon cycle'. As a biomass energy source grows, CO2 is absorbed from the atmosphere and when it is burned the same amount of CO2 stored by the biomass is released ensuring that the natural carbon cycle balance is maintained. This makes biomass briquettes/pellets "carbon neutral."

As opposed to this, fossil fuels like coal are extracted from below the earth, releasing CO2 trapped beneath the soil, into the atmosphere. As this process continues, there is a CO2 overload in the atmosphere, which disturbs the natural carbon cycle, and is one of the culprits behind climate change. Fossil fuels are, therefore, considered to be "carbon negative."

Carbon dioxide emissions from the burning of fossil fuels currently account for about 65 per cent of the extra carbon dioxide in our atmosphere. Carbon from biomass is recycled within one year whereas carbon from fossil fuels such as coal takes 9000 to 12000 years for recycling.

Benefits of Using Biomass Briquettes/Pellets

Environmental Benefits

Biomass briquettes/pellets V/s Coal & Lignite

Coal is a non renewable source of energy.Burning coal emits harmful gases and waste such as carbon dioxide, sulphur dioxide, nitrogen oxides, sulphuric acids, arsenic and ash, and has led to major environmental impacts like acid rain in some regions. Coal excavation requires a significant amount of energy and it is generally transported from remote locations through long distances, leading to higher carbon emissions.

Lignite causes problems in transportation and storage, due to its high moisture and ash content, and is susceptible to spontaneous combustion. It is also difficult to crush, pulverize, and combust. It has a lower heating value, which means that more fuel must be handled to produce a given amount of power. The high inherent moisture content of lignite decreases boiler efficiency. Its ash characteristics require more attention to soot blowing and boiler operation to maintain high availability and reliability.

Variations in quality parameters of lignite /coal like ash content, moisture, GCV result in efficiency losses and variations in steam pressure. High SPM content is also an area of concern, especially in

the case of lignite, and adding to this is the pressure to abide by very strict laws of pollution control boards

Biomass briquettes/pellets manufacturing and transportation leads to lower carbon emissions as compared to fossil fuels, as biomass is abundantly available on site and can be easily collected without significant use of energy. Biomass, after collection, is processed in a vicinity of 50-100 kms from the site of cultivation/harvest, which further reduces the carbon emissions from processing. Biomass briquettes/pellets are a carbon neutral, environment friendly fuel that provide a comfortable, healthy working environment to the manpower involved in collection, processing, manufacturing and usage.

Carbon Emission Reduction Potential

Biomass briquettes/pellets co-firing reduces/displaces fossil fuel use in large coal fired power plants with higher CO2 emission levels. Recognizing that about 50% of tree mass (on a dry basis) is carbon, tree energy crops represent a significant tool for carbon management-having an additional sequestration component which solar/wind energy do not have.

Reduced GHG Emissions

Co-firing biomass briquettes/pellets with coal reduces concentration of GHG emissions by using waste residues, which would otherwise cause carbon dioxide emissions through open burning, or methane emissions through decay.

Sustainable use of biomass briquettes/pellets also addresses the threats associated with global warming, because they are carbon-neutral and reduce SOx emissions to significantly lower levels as compared to conventional fuels.

Economic Benefits

Rural Income & Employment Generation

The use of biomass briquettes/pellets as an energy source generates at least 20 times more local employment within the national economy than any other form of energy per unit. This is because a large amount of unskilled labor is engaged in growing, harvesting, processing, transporting and trading the fuels, which generates off-farm income for rural populations, either regularly or off-

season. Thus, short term and long term employment is created through project activities associated with biomass energy.

There is also an opportunity for revenue generation for suppliers of agro residues viz., small-scale industries and farmers, which enhances development of the region and uplifts the local economy. It also fosters a sense of self reliance in local and rural communities and empowers them to a great extent.

Money Velocity within the Region The most compelling principle of using biomass briquettes/ pellets in co-firing is that, since biomass is cultivated regionally, there is never a monetary drain on a town, city or country. Regional waste problems are addressed and supply is tailored to local needs.

Energy Efficiency V/s Wind & Solar

The average PLF for biomass power projects is much higher as compared to solar and wind, resulting in a significantly higher efficiency of power generation This means that for 1MW power to be generated, biomass stand alone or existing coal fired power plants (where co-firing needs to be done) need to have an installed capacity of 1MW, as the PLF is 0.8. In wind and solar power, the installed capacity needs to be as high as 4 MW or 5 MW as the PLF is very low, 0.2 and 0.15, respectively.

Strategic Benefits

Investment & Benefits within Nation

Biomass based power generation requires comparatively less investment in technology than solar and wind energy, which are highly capital-intensive technologies.

This allows for local industry investments, and larger benefits to the nation in the form of enhanced income and employment generation opportunities.

Increased Energy Security

Local availability and reliability of supply is one of the key advantages of biomass briquettes/ pellets/pellets. Modern applications have demonstrated that biomass briquettes/pellets energy can

be competitive for large-scale industrial applications. For fuel importing countries, the use of local biomass can save substantial amounts of foreign exchange and reduces dependence on other countries for conventional fuels.

Co-Firing In Existing Thermal Power Plant

Co-firing can be done in existing power plants with little or no modifications, allowing for comparatively inexpensive technologies and resulting into rapid reductions in greenhouse gases and local pollutants like SOx ,NOx and SPM.

Besides their potentially harmful effect on the environment, which is well documented, fossil fuels are also a scare resource, and the world is constantly looking for less harmful, more cost effective, and abundantly available renewable energy alternatives, that can replace fossil fuels in energy generation.

Biomass is a widely available resource that can be a powerful substitute for fossil fuels.

Co-firing biomass briquettes/pellets and coal is a win-win combination that offers several key advantages.

Co-firing can be done in existing power plants with little or no modification, allowing for comparatively inexpensive and rapid reductions in greenhouse gases.

It takes advantage of the high efficiencies obtainable in coal-fired power plants.

It also maintains fuel diversity ,which reduces the need for a constant supply of biomass briquettes/ pellets/pellets that would be required in a stand alone biomass power plant.

Co-Firing Helps Meet Renewable Power Purchase Obligation (Rppo) Norms

Different strategies are promoting renewable energy sources for power generation globally. Biomass is a strong contender for renewable energy across the world.

In India too, power sector reforms are underway and the Indian government is promoting renewable energy as a tool to control energy-related GHG emissions.

The Renewable Power Purchase Obligation (RPPO) clearly sets a mandate for including the contribution of renewables to electricity generation.

As co-firing needs less capital investment and less technological modifications, it emerges as a credible renewable technology and is the quickest and most cost effective option to help the country meet its RPPO norms.

Co-Firing With Biomass Briquettes/ Biopellets Vis-À-Vis Loose Biomass

Instead of burning the loose biomass fuel directly, it is more practical to compress it into pellets (compressing them through a process to form blocks of uniform shapes) and thereby improve its utility and convenience of use.

Biomass briquettes/pellets can also be used directly as fuel instead of coal in the boilers.

Biomass Briquettes/Pellets V/S Loose Biomass

Co-firing biomass in a dense briquetted form, known as biomass briquettes/pellets, offers a lot of advantages such as ease in handling, convenience in use, proper combustion and efficient transportation.

Biomass briquettes/pellets are uniform in size, shape, moisture, density and energy content. During its production, biomass is dried in the most efficient way in order to ensure maximum heat generation when it is burned in the boiler. As opposed to this, when burning wet biomass,

additional energy is consumed during the burning process to dry the biomass, thereby increasing the total fuel material consumption and decreasing heating efficiency.

Due to the high density of biomass briquettes/pellets, they can be handled more easily and predicatably in large-scale applications. They also allow for a smaller and simpler conveying system that reduces costs and supports free flow of the biomass fuel through the conveyor system.

There is no technology upgradation required in terms of capacity enhancement for biomass briquettes/pellets, whereas with loose biomass, it is important to consider the possibility of deterioration of capacity due to use of less densified fuel, which may require additional investments in capacity enhancement.

Biomass briquettes/pellets reduce the actual fuel consumption because of proper combustion in the furnace area, thereby increasing the efficiency of the system. It is convenient for continuous

mechanical feeding operation and there is an increase in the life of the boiler.

The high density and uniform shape of biomass briquettes/pellets enables their storage in standard silos. Less storage space is required due to piling of standard sized bags, resulting in savings in storage space and manpower costs, as well as optimal utilization of space. In contrast, loose biomass requires more space due to irregular shaped packaging and piling of bags, leading to increased storage and manpower costs. Biomass briquettes/pellets are also more efficient to transport than loose biomass, because no slack, air and water is being transported.

Conclusion

The use of densified agri wastes for renewable energy for co-firing for power generation and along with fossil fuels for energy needs in Industry would serve as an effective tool of climate change adaptation and mitigation strategy by decreasing carbon-di-oxide and Methane emissions associated with the burning and decay of crop residues and agri-wastes in the agricultural fields after harvesting of crops as well as providing effective renewable energy fuel substitute in the form of biomass briquettes for the energy needs of the country.

It would also contribute to sustainable socio-economic development with social equity as the major project beneficiaries, would be rural population especially in the agricultural dominated regions where agri-waste and crop residue are generated and are available in abundance and the local farming community has a major challenge in disposing them before the next sowing season from their small marginal fields and also would ensure increased access to low cost, clean energy fuel for rural businesses and households as well as industry, institutes, commercial units at costs comparable to the existing fuels being used by them.

It also has capability for ancillary industries development. It would also result in establishment of biomass briquetting and pelleting machine spares and consumables manufacturing units and workshops for manufacturing Die, Ram, Collates, Collete Flenge, V Belt etc locally. This would be a win-win situation for all the stake holders viz. Farmers, Agri enterprenuers, Rural community and Households. Thus it would result in sustainable socio-economic development in the region and effectiveness as the tool of climate change adaptation and mitigation strategy which is an important aspect of the it leading to its widespread acceptance among the various stake holders.

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