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A Review on Alternate Fuels Used In Boilers

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ABSTRACT: Now-a-days fossil fuels such as oils, coal, natural gas etc. represents as the primary energy source which helps to run the present world. The long usage of these fuels can cause a greater impact on the environmental damages such as global warming, acid rain and urban smog, etc. To reduce the carbon emissions, humans are shifting towards the various renewable energy resources such as solar, wind, biomass, water etc. In this, biomass is one of the earliest sources of energy with very specific properties. Several aspects which are associated with burning biomass in boilers have been investigated such as composition of biomass, estimating the higher heating value of biomass, comparison between biomass and other fuels, combustion of biomass, cofiring of biomass and coal, impacts of biomass, economic and social analysis of biomass, transportation of biomass, densification of biomass, problems of biomass and future of biomass.

It has been found that utilizing biomass in boilers offers many economic, social and environmental benefits such as financial net saving, conservation of fossil fuel resources, job opportunities creation and CO2 and NOx emissions reduction. However, care should be taken to other environmental impacts of biomass such as land and water resources, soil erosion, loss of biodiversity and deforestation. Fouling, marketing, low heating value, storage and collections and handling are all associated problems when burning biomass in boilers. The future of biomass in boilers depends upon the development of the markets for fossil fuels and on policy decisions regarding the biomass market.

KEYWORDS: Boiler, Biomass, Fossil fuels, Renewable energy

I. INTRODUCTION

Currently, fossil fuels such as oil, coal and natural gas represent the prime energy sources in the world (approximately 80% of the total use of more than 400 EJ per year). However, it is anticipated that these sources of energy will be depleted within the next 40–50 years. Moreover, the expected environmental damages such as the global warming, acid rain and urban smog due to the production of emissions from these sources have tempted the world to try to reduce carbon emissions by 80% and shift towards utilizing a variety of renewable energy resources (RES) which are less environmentally harmful such as solar, wind, Biomass etc. in a sustainable way.

Biomass is the name given to any organic matter which is derived from plants. That is plant and animal materials such as wood from forests, crops, seaweed, material left over from agricultural and forestry processes, and organic industrial, human and animal wastes. Biomass is a general term which includes Phyto mass or plant biomass and zoomass or animal biomass. The sun's energy when intercepted by plants and converted by the process of photosynthesis into chemical energy, is 'fixed' or stored in the form of terrestrial and aquatic vegetation. The vegetation when grazed (used as food) by animals gets converted into zoomass (animal biomass) and excreta. The excreta from terrestrial animals, especially dairy animals, can be used as a source of energy, while the excreta from aquatic animals gets dispersed as it is not possible to collect it and process it for energy production of the process inthe boiler for better performance.

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II. LITERATURE REVIEW

1. BahaminBazooyar has given an explanation on "Economy of a utility boiler power plant fuelled with vegetable oil, biodiesel and their prevalent blends". In this he explained that by using vegetable oil, biodiesel, Petro diesel will help to decrease the emission of carbon, $NO_x$and also it decreases the total expenditure used for petroleum fuels. We can also use blends for better boiler efficiency.
2. M. Rabaçal, U. Fernandes, M. Costa has proposed "Combustion and emission characteristics of a domestic boiler fired with pellets of pine, industrial wood wastes and peach stones. This study evaluates the combustion of boiler fired with pellets of pine, industrial wood wastes, peach stones and the efficiency of the above products is compared.
3. Lara Carvalho, Elisabeth Wopienka, Christian Pointnerhas given a brief explanation on "Performance of a pellet boiler fired with agricultural fuels". Now-a-days the use of woody biomass has increases the price of limited resources. This leads to the scarcity of the trees on the planet. To avoid this, agricultural fuels can be used as an alternate fuel to burn the boiler for better use. As we can see that this fuel can produce better efficiency not greater than petroleum fuels but can decrease the emission and use of wood for burning.
4. Bahamin Bazooyar, Afshin Ghorbani, Ahmad Shariati has investigated on "Combustion performance and emissions of Petro diesel and biodiesels based on various vegetable oils in a semi-industrial boiler".This paper investigates combustion of Petrodiesel and biodiesels like grape seed, corn, sunflower, soybean etc to determine its performance and gas emissions.
5. Ahmer Ali Siyal, Aaron Low, Rashid Shamsuddin has studied "Fatty acid distillate as an alternative boiler fuel". In this research, we can know that the fatty acid distillate which is a by-product of edible oils can be used as a fuel for boilers. This fatty acid distillate will help to reduce the cost burden on the industries when it is compared with diesel fuels etc.
6. T.M.I. Mahlia, M.Z. Abdulmuin has proposed "An alternative energy source from palm wastes industry for Malaysia and Indonesia". They have studied that the use of palm oil as an alternative fuel will help to decrease the expenditure made on fossil fuels as the palm oils is widely available in those country. The energy is generated from wastes of palm oil. This helps in large savings of the money.
7. Leonel J.R. Nunes,C.O. Matias has evaluated "Evaluation of the utilization of wood chips as fuel for industrial boilers". In this, they study the use of maritime pine non-debarked woodchips as an alternate fuel in industrial boiler in Portugal. They also studied the emission of ash produced by the wood and chemical composition of ash is determined by the process called scanning electron microscope.
8. Mohammad A. Hamdan and Derar A. Almomani has performed "Performance study of a Domestic boiler fuelled by biodiesel produced from Rapseed". A domestic boiler was used in this work to compare its performance when it is powered by diesel fuel and biodiesel fuel that isproduced from rapeseed oil, then blends of both fuels were prepared with different concentrations of biofuel (B5, B10 and B20). The Performance of a domestic boiler when operating using B20, B5 and B10 blends hassimilar fuel consumption and efficiency when it is powered by petroleum diesel fuel.
9. Varia Niraj, Rathod Darshan has given a review on "A review in performance measurement of diesel fired boiler using coconut oil". In this, we can say that by using coconut oil will help use to decrease the problems like short supply and emission of diesel fuels demands for alternative fuel which have same performance and better emission characteristics biodiesel made from non-edible oil. It offers advantages like higher cetane number, reduced emissions etc.
10. Daniel Bernhardt, Kathrin Gebauer has studied "Investigation of combustion behaviour of pulp pellets in a domestic pellet boiler". In last few years importance of biomass like wood etc has increased. To counteract this other biomass like agricultural residues are used. In this, they have pulp which is developed from waste for efficiency.
11. TâniaFerreirahas performed "Performance assessment of invasive Acacia dealbata as a fuel for domestic pellet boiler". This study evaluates the combustion and emissions characteristics of a commercial wood pellet boiler with a nominal thermal output of 20 kW using purposed-manufactured Acacia dealbata pellets. The thermal efficiency and emissions of the invasive species pellets were compared at three different predefined operation loads. The obtained results show that, for the same fuel mass flow rate, the best boiler efficiency was always achieved with Pine pellets.

12. Eugeniusz Orszulik has given brief on "Combustion of alternative fuel composites containing municipal sewage sludge in power boilers". From this we can say that municipal waste like sewage sludge can be used as an alternative fuel in energy generation and heating. There isn't need any major changes in boiler to use sewage sludge as alternative fuels.
13. D. Naumenkohas discussed "Analysis of use of trapa natans as alternative fuel for boiler". Biofuels have less effect on the greenhouse effect, because plants that then use as biofuelsabsorb carbon from the atmosphere and produce oxygen. The properties of Trapa natans spread and multiplyrapidly, make it possible to consider it as an alternative fuel for boiler houses of the hot water supply system (HWS).The necessary amount of Trapa natans, firewood and coal required to heat 500 litres of water from 30to 100 °C has been established. It has been proved that Trapa natans can be used as an alternative fuel for boilersystems of HWS for enterprises adjacent to reservoirs.
14. Clement Tom Scaria has given report on "Usage of alternative fuel in boiler for cost reduction in a chemical industry". From this study it is found that furnace oil is the mainly used fuel in chemical industry. Mainly it is used in the operation of boilers, as steam is an important requirement in every chemical industry. So alternate fuels can help to decrease cost reduction in chemical industry.
15. Y.P. Olisahas studied "Utilization of palm empty fruit bunch as solid fuel for steam boiler". This study therefore examined the utilization of empty fruit bunch (EFB) as an alternative fuel for firing a steam turbine plant for the production of electricity. The power plant used for this study produces 1.5 MW of electricity by burning EFB at the rate of 840 Kg per hour, given the same rate of combustion, this value was compared to a conventional power plant fired with methane gas which produces 4.35 MW.
16. Michael S. Kaylen has given a analysis on "An economic analysis of using alternative fuels in a mass burn boiler". the economic feasibility of using alternative fuels in a mass burn boiler for a chemical plant in northeastern Missouriis analysed Research reveals an abundance of alternative fuels for which the plant would receive a tipping fee, including municipal solidwaste and used tires. Since the plant would have to pay for biomass, it does not appear in the optimal solution.
17. Masooma Nazar has given brief on "Techno-economic and environmental assessment of rice husk in comparison to coal and furnace oil as a boiler". The aim of this study was to analyse the cost and technological benefits of rice husk as boiler fuel by comparing itwith primary boiler fuel like coal and furnace oil. Rice husk is a major agricultural waste that has the potential toproduce clean energy. This study was based on the collection of data on boiler site, and measurements of stackemissions. Through the collected data, the annual fuel, labour, operational and maintenance costs, as well as ashdisposal, chemical costs, payback period, the lifetime of the plant, particle control methods, and efficiency of theboiler were determined.
18. Kai Husmann has studied "Biomass functions and nutrient contents of European beech, oak, sycamore maple and ash and their meaning for the biomass supply chain". This study tells us the nutrient contents present in European beech, oak etc which can be used as an alternative fuel in the boiler. These biomasses will help us to increase the boiling efficiency of the product. They contain less moisture which can be an advantage for the boiler.
19. Larry Baxter has given report on "Biomass-coalco-combustion:opportunity foraffordable renewableenergy"This investigation explores thereasons for and technical challenges associated with co-combustion of biomassand coal in boilers designedfor coal (mainly pulverized coal) combustion. Biomass-coal co-combustion represents a near-term, low-risk, low-cost, sustainable,renewable energy option that promises reduction in net CO_2 emissions, reduction in SO_x and often NO_x emissions, and several societalbenefits.
20. Fares A. Alaw and Nurul S. Sulaiman gives a review on "A Review of Boiler Operational Risks in Empty Fruit Bunch Fired Biopower Plant". In this we can learn that by using empty fruit bunch fired with biopower plant can cause overheating, oxygen corrosion and clinker etc. The overview of risks not only provide a perspective from which an industry's viabilitycan be evaluated but also help the operators to better understand key risks and improve boilercapacity as well as plan their risk mitigation strategies more effectively.
21. Udara SPR Arachchige has explained "Alternative fuel for biomass boilers in Sri Lanka". In Sri Lanka to avoid the use of wood alternative fuels like rice husk, Dendro etc is used to generate energy for personal needs.

22. R. Saidur gave a review on"A review on biomass as a fuel for boilers". In this review, several aspects which are associated withburning biomass in boilers have been investigated such as composition of biomass, estimating the higherheating value of biomass, comparison between biomass and other fuels, combustion of biomass, cofiringof biomass and coal, impacts of biomass, economic and social analysis of biomass, transportationof biomass, densification of biomass, problems of biomass and future of biomass.
23. Roberto García Fernández studied "Study of main combustion characteristics for biomass fuels used in boilers". In this context biomass appears as an attractivefeedstock, because of that a comprehensive characterization is needed, focusing morphological study, usingscanning electron microscope (SEM) and particle size distribution, composition with X-ray dispersive energy(EDX), thermal analyses, using thermogravimetry and combustion gas analysis, to select the best behaviour asa fuel from six biomass samples (almond shell, rice husk, straw, vegetable coal, wine pomace and a randomlychosen commercial brand of wood pellets) trying to comb all the range of commercial fuels most commonlyavailable in the Spanish solid biofuel market.
24. E.G.A. Forbes has studied "Physio-chemical characteristics of eight different biomass fuelsand comparison of combustion and emission results in a small-scale multi-fuel boiler". This study describes the results from the investigation of 7 different biomass fuel types produced on afarm, and a commercial grade wood pellet, for their physical, chemical, thermo-gravimetric and combustionproperties. Three types of short rotation coppice (SRC) willow, two species of conifers, forest residues(brash), commercially produced wood-pellets and a chop harvested energy grass crop Miscanthusgiganteus spp., (elephant grass) were investigated.
25. Fabio Schiro gave brief on "Modelling and analysing the impact of Hydrogen Enriched Natural Gason domestic gas boilers in a decarbonization perspective".The aim of this research is to generate knowledge on the effectof hydrogen enrichment on the widely used premixed boilers: the investigations include pollutantemissions, efficiency, flashback and explosion hazard, control system and materials selection. A model forcalculating several parameters related to combustion of hydrogen enriched natural gas is presented.Guidelines for the design of new components are provided, and an insight is given on the maximumhydrogen blending bearable by the current boilers.
26. C.D.Barnes has explained "The use of biodiesel blends in domestic vaporising oil burners". The purpose of this study wastherefore to investigate the use of different blends of biodiesel and kerosene in a productionthatemployed a sleeve-type vaporising burner. It was found that significant fouling of the burner well wouldoccur within a short period of time, even with a blend as low as 5% by volume of biodiesel in kerosene.
27. Gunther Fischer made a publication on "Globalbioenergy potentials through 2050". As an illustration of the circumstances under which a large part ofthis potential couldbe used in practice, a global energy scenario with high economic growth and low greenhouse gas emissions, developed byIIASA and the World Energy Council is summarised. In that scenario, bioenergy supplies 15% of global primary energy by2050. Our estimation method is transparent and reproducible.
28. T. Daho has explained "Optimization of the combustion of blends of domestic fuel oil and cottonseedoil in a non-modified domestic boiler". This study characterizes combustion of blends of DFO (domestic fuel–oil) and refined cottonseed oil producedin Burkina Faso at different percentages in a non-modified DFO burner by determining its overallperformance (consumption and thermal capacity) and gas emissions (CO, CO2, O2, NO, NOx, SO2). Thephysical and chemical characteristics of the different blends confer on each blend the status of a specialfuel requiring specific adjustment of the burner.
29. Caio Pereira has studied "Combustion of biodiesel in a large-scalelaboratory furnace".Combustion tests in a large-scale laboratory furnace were carried out to assess the feasibility of usingbiodiesel as a fuel in industrial furnaces. For comparison purposes, petroleum-based diesel was also usedas a fuel.
30. Hoon Kiat Ng has made work on "Combustion performance and exhaust emissions from the non-pressurisedcombustion of palm oil biodiesel blends". In this work, levels of exhaust species from the combustion of palm oil methyl ester (POME) and itsblends with No. 2 diesel in a non-pressurised, water-cooled combustion chamber are evaluated. Thestudy explores the correlations between

emission species and fuel pumping pressures over a range ofequivalence ratios (ERs).

III. CONCLUSION

By observing and experimentations we can conclude that by using of biomass fuels is more efficient for boiler. Because it does not produce and release any type of harmful or toxic gases into environment and also the usage of biomass fuels will increase the efficiency and increases the lifespan of the boiler. It helps to avoid the exploitation of natural resources like coal, diesel, petroleum etc. to decrease the pollution and to repair the environment. So, biomass helps the boiler to increase their efficiency and life to complete our needs. It is a carbon neutral source of energy because when fully combusted the amount of carbon dioxide produced is equal to the amount which was taken from the atmosphere during the growing stage.

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