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Comparative Emission Analysis Of Bituminous Coal, Sugarcane Bagasse and Rice Husk

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Abstract: Coal is largely used as a fuel for power generation. However, combustion process of coal is accompanied by the release of anthropogenic emissions. If sugarcane bagasse and rice husk are used as alternative fuel to bituminous coal in electrical power generation process the amounts of harmful emissions can be minimized. Sugarcane bagasse rice husk are produced as by-products from sugarcane and rice commodities in respective industries this paper analyses combustion processes of bituminous coal, sugarcane bagasse and rice husk and the amounts of CO, CO2, SO2, Nox released in grams per kWh of electrical power generation. A comparative analysis of bituminous, sugarcane bagasse and rice husk is carried out in order to determine estimated amounts of emissions releasing from these fuels in order to evaluate suitability of either of fossil or biomass fuels. The results of the analysis are promising in terms of remarkable difference in the amounts of these emissions released during their burning processes.

Keywords: Fossil fuel, anthropogenic emissions, biomass energy, environmentally sustainability,

1. INTRODUCTION

Fossil fuels are commonly used as a fuel for electrical power generation. Coal natural gas and crude oil are used for medium and large scale generation of electrical power worldwide Mohar *et al* (2015) and Shah and Zhang, (2010). However, these fuels are limited and have tendency to affect environment adversely. Anthropogenic emissions are released due to combustion of coal, crude oil and natural gas in electrical power generation processes, which creates environmental pollution Shah and Zhang (2010) and Shah and Edwards (2011), Shah *et al*, (2013).

Therefore, alternative fuels are being explored in order to cater needs of energy in efficient and environmentally safe manner. Renewable energy sources have emerged as alternative fuels to fossils Shah *et al* (2015) and Harijan (2015). Share of renewable energy sources in various sectors of economy is growing. Renewable energy is capable to replace the conventional fuels in four different areas: electricity generation, vehicle fuels, air and water heating and rural energy services Destouni and Frank (2010).

Biomass energy has emerged as an alternative renewable energy fuel worldwide. According to renewable 2014 Global Report, 9% of energy consumption is coming from traditional biomass, 4.2% as heat energy (non-biomass), 3.8% hydroelectricity and 2% is electricity from wind, solar, geothermal sources.

Agricultural residue is a type of biomass, which refers to residue produced in fields or farm during harvesting and other activities Agricultural residue includes cereals, crops, and sugarcane. Agriculture residue exist in the form of olive pits, fruit pits, wheat straw, walnut shells, corncobs, corn Stover, sugarcane bagasse, rice hulls and peach pits Saidur *et al* (2011). Nowadays it is possible to use a biomass boiler for electrical power generation at small, medium and large scale. Sugarcane Bagasse and rice husk are used as alternative fuels for electrical power generation worldwide. In Indonesia rice husk is utilized as a fuel for electrical power generation in various parts of world Ansar *et al* (2016). Likewise in Brazil biomass based gasification process using sugar cane Bagasse are used for electrical power generation Riehl *et al*, (2010). Rice husk and sugarcane are produced in rice and sugarcane industries a s a by product in Pakistan and can be used as fuel for power generation. It is estimated that if 70% of rice husk residues are utilized, there will be annual electricity production of 1,328 GWh Mohiyuddin *et al* (2016). In order to explore the potential of sugar Bagasse and rice husk as a fuel for small and medium scale electrical power generation a comparative study on bituminous coal, sugarcane bagasse and rice husk is carried out in order to determine the amounts of CO, CO_2, SO_2, No_x which are released during the burning of these fuels and on basis of least amounts of these amount to determine suitable fuel that can be used in electrical power generation process.

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2. RESEARCH METHOD

Questionnaire and survey techniques are used for collection of respective CO,CO_2, SO_2, No_x data of bituminous coal, rice husk and bagasse from coal fired power plant Jamshoro power plant, Khairpur Sugar Mills Pvt Limited, Ranipur Sugar Mills Pvt Limited and SSJD group biomass fuelled power plant. Khairpur Sugar Mills Limited which is producing 11MW power daily and about 6000 metric ton sugarcane is crashed. While 2300 metric ton bagasse is produced The sampled data was then processed and analyzed keeping in view the scope of the research. In the Emission analysis the amounts of carbon dioxide (CO_2), carbon mono oxide (CO), sulphur dioxide (SO_X) and nitrogen oxide (NO_X) produced during the burning of fuels in combustion process on basis of amounts of carbon content presence. Coal has higher amounts of carbon dioxide because of high percentage of carbon content. Likewise amounts of carbon dioxide in sugarcane bagasse and rice husk because on basis of presence of carbon content. Gas analyzers were used for the measurement of amounts of CO, CO_2, SO_2, No_x . Charts and graphs were used for the representation of data. Accuracy and precision was maintained at the stages of data collection, processing and analysis.

3. RESULTS AND DISCUSSIONS

The emission amount that are produced during the combustion of bituminous coal, bagasse and rice husk are obtained on basis of the sampled data and a comparative analysis of CO, CO_2, SO_2, and NO_X emissions is discussed below.

I-CO Emissions of Bagasse, Rice husk and Sub Bituminous Coal

The amounts of CO emissions, which are released when burning bagasse per ton of burning of bituminous coal, sugarcane bagasse, rice husk are estimated are shown in **(Fig.1)**.

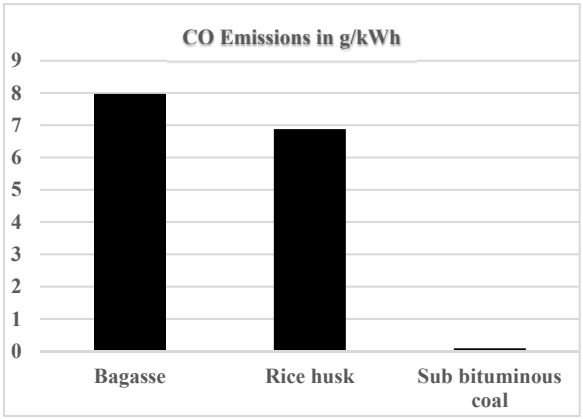


Fig.1.Estimated amounts of CO emissions released in g/kWh electrical power generation from sugarcane bagass, rice husk and bituminous coal

(Fig. 1) shows that CO emissions of rice husk (6.88g/kWh) are less than that of sugarcane bagasse (7.87 g/kWh) and are more than bituminous coal (0.0895 g/kWh). Cogent reasons for these differences are incomplete combustion process of sugarcane bagasse and rice husk, while CO emissions of sub bituminous coal are very low because of the reason that there is almost complete combustion. The other reason for these is that there is more moisture content in the bagasse which causes more heat used to remove it so more emissions are produced from the point of view of unit electricity generation, whereas CO emissions released from coal are negligible, as the complete combustion of coal causes less CO emissions and more power production from same amount of coal as compared to the bagasse or rice husk. Therefore sub bituminous coal may be considered less harmful in release of carbon mono oxide emissions per kWh generation of electrical power efficient from bagasse and rice husk.

II-CO_2 emissions of Bagasse, Rice husk and Sub Bituminous Coal

The amounts of CO_2 emissions, which are released when burning bagasse per ton of burning of bituminous coal, sugarcane bagasse, rice husk are estimated are shown in **(Fig.2)**.

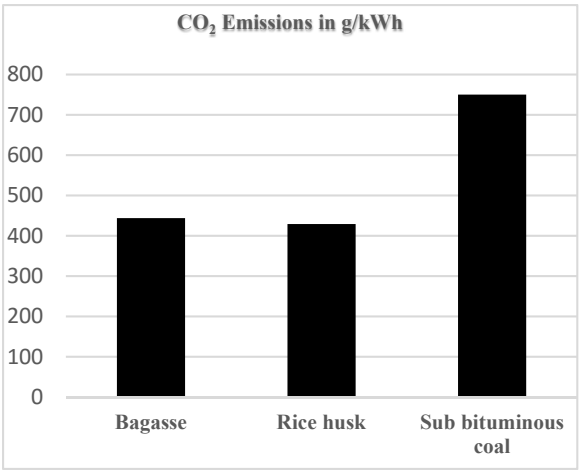


Fig.2. Estimated CO_2 emissions of Bagasse, Rice husk and Sub Bituminous Coal in g/kWh.

From the (Fig. 2) it is clear that from combustion of coal a huge amount of CO_2 emissions (750 g/kWh) is produced as compared to bagasse (443g/kWh) and rice husk (429g/kWh) because of the reason high amount of carbon content in bituminous. Here it was noted that oxygen gas taken from the environment chemically reacts with carbon causes higher weight of carbon dioxide. Therefore by using bagasse and rice husk for electrical power generation, CO_2 emissions can reduce to some extent.

Percentage emissions reductions are also estimated on basis of per ton combustion of these fuels (sugarcane bagasse, rice husk and bituminous coal). It was observed that using bagasse as an energy source for electrical power generation, CO_2 emissions can be reduced up to 66% as compared to per ton combustion of same weight of sub-bituminous coal, while 40% emissions of CO_2 can be reduced per unit electricity generation, if rice husk, is used instead of coal in power generation. The CO_2 emissions can be reduced to 57% from point of view of per ton combustion of sub-bituminous coal. Further about 42% CO_2 emissions can be reduced by using rice husk in comparison to sub-bituminous coal for unit electricity generation. Therefore rice husk produces fewer amounts of CO_2 emissions as compared to bagasse and sub bituminous coal.

III-Estimated SO_2emissions of Bagasse, Rice husk and Sub Bituminous Coal

The amounts of SO_2 emissions, which are released when burning bagasse per ton of burning of bituminous coal, sugarcane bagasse, rice husk are estimated are shown in **(Fig.3)**,which shows that higher emissions amounts of sub bituminous coal as compared to bagasse and rice husk emissions.

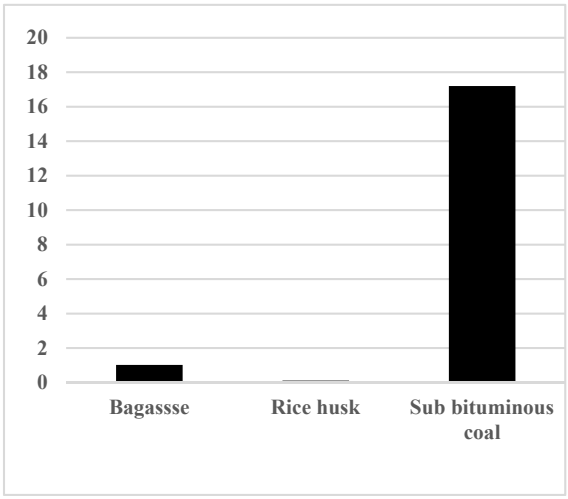


Fig.3. Estimated SO_2 emissions of sugarcane bagasse, rice husk and Sub Bituminous Coal in g/kWh

This figure shows the SO_2emissions released by sub bituminous coal (6.15 g/kWh) emissions are higher in comparison to rice husk (0.054 g/kWh), which are even less than the emissions of bagasse (0.64 g/kWh) are considerable up to some extent. Therefore, rice husk is considered a suitable source for power production and avoiding the SO_2emissions. Rice husk can be used along with bagasse. So by using biomass energy sources SO_2emissions can be decreased.

Estimated percentage emission reductions are also worked out. It was noted that by replacing sub-bituminous coal with sugar cane bagasse as a fuel SO_2 emissions can be reduced up to 94% per ton combustion in electrical power generation. These emissions can be further reduced up to 89% by using it as energy source per unit electricity generation by replacing sub-bituminous coal with rice husk. Therefore rice husk produces less amounts of SO_2 in comparison to bituminous coal and sugarcane bagasse.

IV-NO_X emissions of Bagasse, Rice husk and Sub Bituminous Coal

The amounts of SO_2 emissions, which are released when burning bagasse per ton of burning of bituminous coal, sugarcane bagasse, rice husk are estimated are shown in **(Fig.4)**.

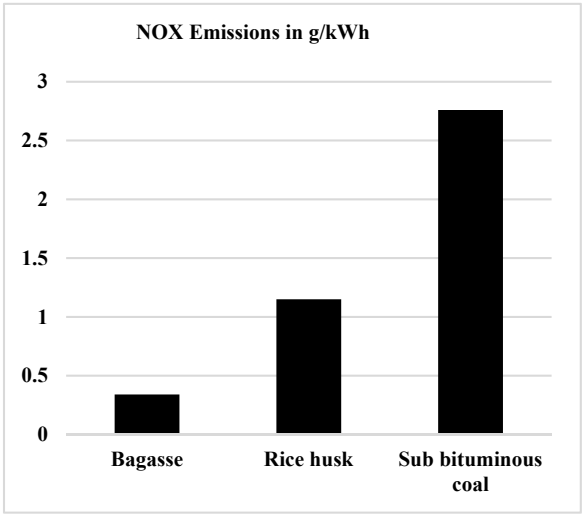


Fig.4. Estimated NO_x emissions of sugarcane bagasse, rice husk and Sub Bituminous Coal in g/kWh

From the **(Fig.4)** it is can be observed that NO_X emissions of bagasse (0.34 g/kWh) and rice husk (1.15 g/kWh) are less than that of sub bituminous coal (2.76 g/kWh). Since rice husk produces little more NO_X emissions from bagasse, therefore bagasse may be considered as more efficient fuel for power generation in replacement of coal

The (Fig.4) also shows that sub bituminous coal produces more emissions of NO_X and bagasse produced again fewer amounts of these types of emissions. So bagasse can be considered to reduce pollution and is more suitable fuel for power generation.

4. CONCLUSION

Since sub bituminous coal produces more emissions of NO_X, CO_2 and SO_2 than sugarcane bagasse and rice husk, a gradual switch over to these biomass fuels may help in the reduction of anthropogenic emissions, which

are released during combustion processes in electrical power generation processes and could contribute towards reduction of air pollution. Therefore biomass fuels sugarcane bagasse and rice husk can be considered as suitable fuel for power generation and can be considered as an environmental friendly fuel source for power generation.

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