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Pyrolysis of Biomass as a source of Renewable Energy Generation- A Review

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***Abstract*— One of the most complex problem today the world facing is regarding the control of greenhouse gas emissions and their deleterious effects on the environment like increment in overall temperature causing global warming. The use of fossil fuels dominates the energy production, causing environmental problems, unless we find the new substitute source of energy. Biomass is a renewable energy source and it is an alternative option of energy in the form of liquid fuel, gas, and bio char. Biomass is a carbonaceous material. The type of biomass, the size, moisture content, type of catalyst and also, the operating conditions like temperature are considered during this pyrolysis process. This paper reviews the previous work carried on solar-thermal conversion of biomass through pyrolysis process. The process of energy generation, the basic principles and application of biomass pyrolysis as well as some of the factors that can affect pyrolysis of biomass to produce bio-fuel is also summarized in this paper.**

Keywords*— *Biomass, bio-fuel, solar biomass conversion, renewable energy, solar pyrolysis

I. INTRODUCTION

In today's scenario, the energy demands goes on increasing due to the population growth, urbanization and current developments. This requires the energy sources to fulfill their energy needs. The world is moving very fastly towards two major crises: serious energy shortages and accelerating climate change. This led to ongoing research on renewable and clean energy resources. The solutions to both the crises are interlinked with each other as the diversification of the fuel base and adoption of emerging clean and green alternatives for energy production. Biofuel production is a promising technology, which can contribute to develop future environmental friendly energy systems in order to increase the share of renewable energy in various fields like heating, electricity, transport fuels and higher applications. Biomass is a renewable energy source of a carbonaceous material. So, there is need to give special prominence on biomass conversion using solar energy [16]. According to the International Energy Agency (IEA), the current total contribution from solar and biomass resources to the total world energy supply is only <1.5% and <10.5%, respectively [9]. This paper reviews the previous work carried on Solar-thermal conversion of biomass through pyrolysis process. Pyrolysis is a thermal decomposition process that takes place in the absence of oxygen to convert biomass into solid charcoal, liquid (bio-oil) and gas.

II. LITERATURE REVIEW

Muktar Bashir et. al [1] presented a theoretical study on pyrolysis of biomass in a solar-thermal reactor heated by a parabolic trough concentrator. The conversion of biomass through pyrolysis process is an alternative option to store energy in the form of liquid fuel, gas, and bio char. The following figure 1.1 gives idea of the model for solar-thermal conversion of biomass. The proposed reactor performance can be analyzed in terms of thermal conversion efficiency and its environmental impact. The researcher found that the reactor gives the overall efficiency of 67.8% with products, 51.5% of bio-oil, 43.7% of char and remaining non-condensable gases.

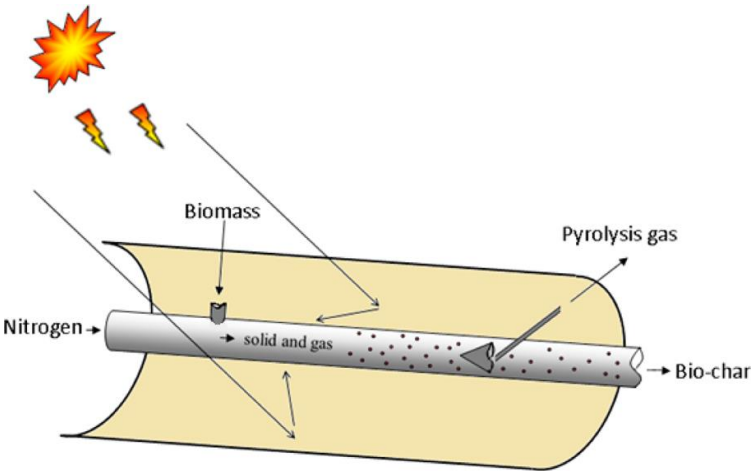

Fig. 1.1 Model for Solar-thermal conversion of biomass [1]

This study presented a computational fluid dynamic (CFD) model and performance analysis of a novel solar-thermal reactor for the conversion of biomass. It also confirmed that the proposed reactor having great potentials and

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competitiveness, when compared to other types of solar and conventional reactors.

This study given more emphasis on different solar chemical reactions available for biomass conversion and the use of concentrated solar radiations for this conversion. The use of concentrated radiation enhances the solar thermochemical process and gives better results. Pravin Badarayani [2] had used the small samples of cellulose as a carbonaceous material and concentrated solar energy can be used to drive the thermochemical processes. He predicted the results by using various kinetic models and also, it is necessary to determine its products of polymerization such as thermal conductivity, mass density, heat capacity, etc., more accurately. The author concluded that concentrated solar radiation can be used to drive thermochemical reactions for the preparation of energy carriers.

This paper concerned with the pyrolysis of biomasses using solar-thermal energy. H. Grassmann et. al [3] focused the unprocessed agricultural residues or woody wastes typically degrade over time due to natural deterioration since, they are highly prone to decomposition and breakdown processes due to uncontrolled environmental conditions for pyrolysis processes. They used only the thermal solar energy provided by a system of reflecting mirrors (Linear Mirror II) to heat a selected agro-waste biomass, such as wheat straw. The biomass contributes to less than 10% of the total energy supplies in industrialized countries, but only 3.0 to 3.5% of the yearly produced biomass is used in applications not related to foodstuff [10] [11]. This thermal process provides an efficient, environmentally acceptable, and cost-effective method for the capitalization of a sustainable energy source [13] [14].

Roman Adinberg et. al [4] described the conversion of cellulose particles as a biomass to synthetic gas which is carried out using concentrated solar energy supplied by a solar plant. The dispersion of biomass particles in a molten inorganic salt medium provided with solar energy in order to perform pyrolysis reactions in the high temperature liquid phase. They also suggested that the presence of molten salt might enhance the reaction of char gasification and feasible option for continuous production of synthetic gas. This is the clean and green source of energy for production of synthetic gas.

This paper compared a single biomass particle pyrolysis model in suitable software with the experimental data which is obtained from an image furnace, where biomass pellets are submitted to a controlled and concentrated radiation. M. Al-Haddad et. al [5] concluded that there is a existence of two distinct layers inside the pyrolyzing sample- unreacted wood and char. They also suggested that the kinetic parameters have to be further optimized and validate with fast pyrolysis experimental data.

The biomass flash pyrolysis is an advanced technology of the thermochemical conversion process. Hongling Yu et. al [6] had used pinewood sawdust as a biomass and investigated three kinds of products viz. solid, liquid and gaseous and maximum reaction temperature in the range of $450 - 540^0C$. The reaction temperature range, the short remaining time and rapid heating rate are unfavorable to the carbonization of the solid product [14], which needs a lower temperature ($<400^0C$) and a longer reaction time, so the yield of carbon particles reduced. The investigation shows that the reaction temperature should have the impact on the pyrolysis process like type of products and yields of bio-oil.

This study [7] preferred the Bambara groundnut shell, a residue from food crop as a green and sustainable bioenergy source of for production of biofuels. Energy analysis of products evaluated that it is the comprehensive thermochemical process gives optimum yield of 36.49% by weight having reaction temperature of 600^0C. They also investigated the decomposition behavior and kinetic parameters of Bambara groundnut shell and the effects of pyrolysis temperature, heating rate and nitrogen flow rate on biomass conversion process.

M.G. Rasul et. al [8] identified path of pyrolysis technology i.e. selection of biomass for pyrolysis, types of reactor, reaction temperature and product output- bio-oil, bio-char or synthetic gas. The biomass conversion through thermochemical process is not fully developed, though the lot of research is going on in this area. From previous researches it is found that biomass to bio-fuel conversion has lot of challenges and need to overcome.

III. CONCLUSION

This paper has reviewed the current state of research on biomass pyrolysis using conventional as well as non-conventional sources of energy and their further development for the use of solar technologies for biomass processing and conversion to biofuels. The most of the researchers has predicted that the conversion of biomass using solar energy is a green and sustainable source of bio-fuel production. Hence, it can be concluded that the much attention has to be given to the development of thermochemical conversion process of biomass, which provides the platform for the use of agricultural wastes, wood materials, household or commercial solid wastes into clean energy, etc. Bio-fuel production through solar pyrolysis is still not fully developed technology and is not commercially feasible yet. To cope with the energy demands in future, the use of biomass energy is a good option over conventional sources of energy and also, the development of these thermochemical conversion processes is presented as future scope.

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