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Pyrolysis for bio-fuel production: Agricultural Residue Management Technique

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Background

Worldwide increasing demand of energy, day by day raising the prices of gasoline, diesel etc. and distress towards the global climate change has been paid a rapid attention on alternative fuels that can displace the commercial or fossil fuel. There is an undeniable thing that human being reliance on energy to quench the hunger of liquid fuels (biofuels, and other liquid fuel. In addition, according to British Petroleum Global (2016) about 97% of the raise in global oil consumption, it might be due to increasing human population (Sharma et al. 2019). Presently, biomass is considered as one of the most significant renewable energy resources for protecting the future energy demand and supply, production of alternative energy sources and sustainable development. Lignocellulosic biomass is representing the biggest potential volume and minimum cost for alternative fuel production.

Classification of biomass conversion processes

Biomass conversion can be achieved into different useful forms of energy by conducting different conversion processes. Fig. 1 portrays the classification of several routes of biomass conversion process. Therefore, conversion of biomass to energy is achieved using two main processes as follows;

I. Thermo-chemical conversion of biomass

II. Biochemical conversion

Thermal conversion process

Thermo-chemical conversion of biomass encompasses four main routes; Combustion, pyrolysis, torrefaction, and gasification. Among these routes, pyrolysis is considered as one of

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the economical methods for bio-fuel production. Pyrolysis is considered as primary stage of all thermo-chemical processes in which chemical reaction occurs by producing solid (e.g. charcoal), liquid (e.g. oil) and gas (e. g. Synthetic gas) fuels in absence of oxygen. Energy content in biomass is being released directly as a heat or hot flue gas via combustion process at high exothermic temperature, biomass upgrading via torrefaction process in which biomass is heated at moderate temperature range from 200-300^{o}C, without oxygen environment. Unlike combustion process, in biomass gasification process chemical reaction occurs in oxygen deficient environment by producing a producer gas with a heating value.

- Combustion
- Pyrolysis
- Torrefaction
- Gasification

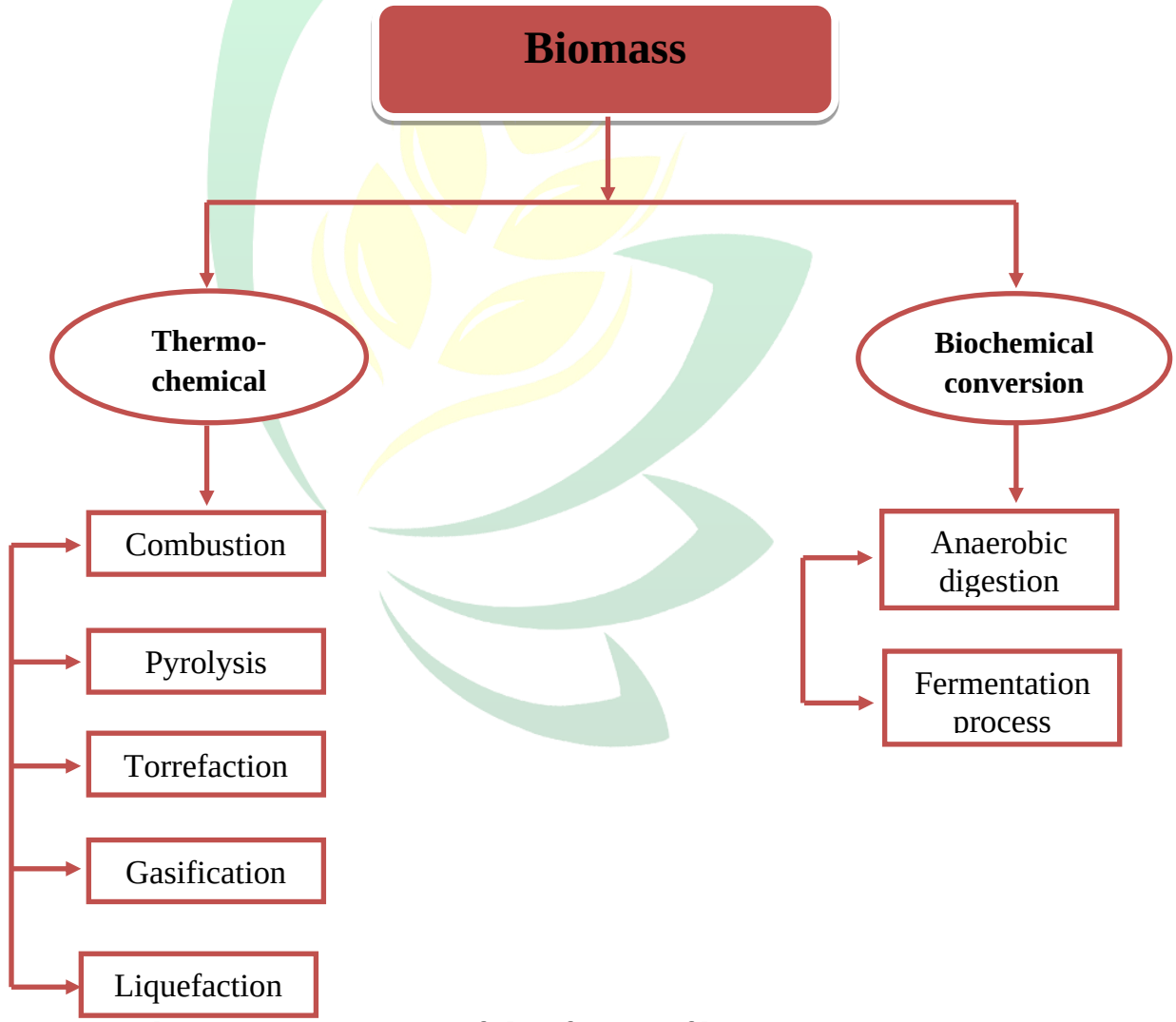

Fig. 1: Schematic representation of classification of biomass conversion processes.

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Pyrolysis

Pyrolysis is the thermal decomposition of biomass into solid (charcoal), liquid (bio-oil), and gases (combustible gas) products at temperature range from 400 - 500^{o}C, in absence of oxygen. High process temperature allows devolatilization of gases; those vapours are further condensed into liquid (bio-oil) by liquefaction process. Unlike combustion process, pyrolysis reaction is not exothermic and takes place in absence of air except in some cases where limited supply of air is needed. In pyrolysis, hydrocarbon molecules of biomass are subsequently broken down into smaller ones. Fast or flash pyrolysis reaction mainly gives liquid fuel, named as bio-oil, whereas slow pyrolysis or carbonization mainly used for biochar and syngas generation. The liquid fuel from pyrolysis process could be stored and subsequently utilized for different thermal and electrical application. In addition to bio-oil fuel, solid product i.e. charcoals, value added chemicals and syngas might be used as alternate fuels in thermal and industrial application. In pyrolysis process, approximate yields of end products from 100 kg of wood biomass are: 30 kg char, 14 m^3 of syngas (calorific value 10.4 MJ/m^3), 7.6 L of oil with tar, 5.3 L of acetic acid, 1.4 L of methyl alcohol, 0.8 L ester, etc. Therefore, pyrolysis is promising process for conversion of organic waste into value added fuels products such as liquid oil, charcoal and syngas.

Applications of bio fuels:

The application of biofuels as an alternative source may minimize the environmental pollution, improve the agriculture economy, build up new job opportunities, reduce the fossil fuel requirement, and thus application of biofuel contributes in strengthen and conserving the various commercial energy sources. However, some of the biofuels can utilize directly. while other fuels are required some formulation to bring its characteristics relevant or closer to fossil fuels. Fig. 2 indicates the major applications of biofuels. Here, some applications of biofuels are listed below in point wise;

- Biofuels can be used as a transport fuel to replace the fossil fuels like gasoline, diesel etc.
- Biofuels used for thermal power generation
- Fuels used for fuel cell through thermochemical conversion
- Biofuels used in power vehicles, cooking, and for electricity generation.

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- Biofuels for engine application
- Solid biofuels can be used as domestic cooking application.
- Application in cogeneration system
- Biofuel application in chemical industry

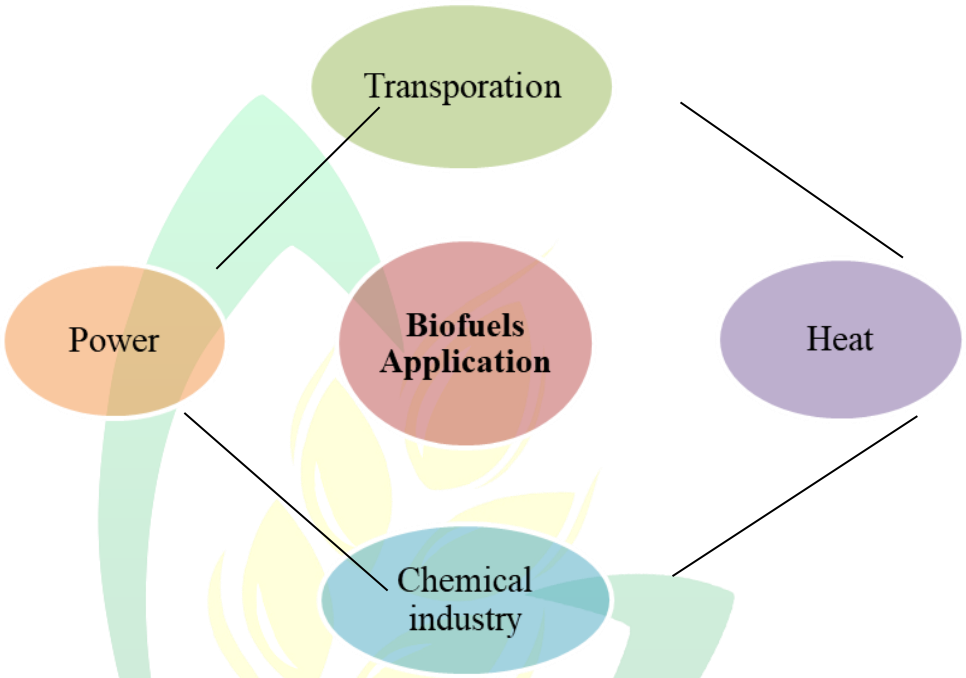

Fig 2: Major applications of biofuels

Conclusion

Replacement of conventional energy sources with biomass derived fuels can bring an optimistic impact in numerous prospective, i.e., environmental, economics, and health. Moreover, biofuels obtained through different conversion routes could be achieved at any type of geographical condition, where large availability of raw material and simultaneously achieve an effective management of biomass waste.

References:

Sharma, HK., Xu, C., and Qin, W. (2019). Biological pretreatment of lignocellulosic biomass for biofuels and bioproducts: an overview. Waste and Biomass Valorization, 10(2): 235-251.