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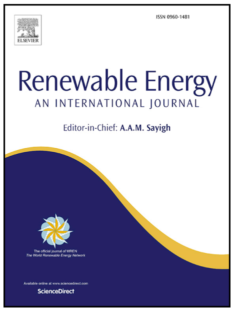

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BIOMASS TO BIOFUELS: CHALLENGES AND OPPORTUNITIES

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IUPAC defines biomass material produced by biological growth (microorganisms, plants, animals, etc.) [1]. Unlike fossil fuel, biomass takes a relatively short time to develop. According to this definition biomass can be classified as follows:

- virgin material, purposely generated for energy production (wood, corn, etc.)
- agroforestry and industrial residues (straw, bagasses, manure, etc.);
- biodegradable waste fractions (food waste, sewage sludge, exhausted oils, etc.)
- harvested biomass (crops and algae) cultivated by using liquid waste

Biomass is increasingly considered as a strategic source for generating alternative renewable energy, reducing the use of fossil carbon based resources.

Conversion to energy could be direct (e.g. combustion of wood) or indirect by production of fuels (biofuels). They can be liquid (ethanol, methanol, biodiesel as FAME-Fatty Acids Methyl Esters, vegetable oil, and pyrolitic oil), gaseous (biogas, syngas, methane, hydrogen etc.) or solid (biochar).

The technological options for conversion of biomass to biofuels are based on different kind of processes, depending on origin, quality and pretreatment of the specific biomass, as schematically represented in Figure 1. They can be classified as follows: Biological conversion (anaerobic digestion, fermentation), Low Temperature (generally <300°C) Thermochemical conversion (torrefaction, hydrothermal liquefaction, hydrothermal carbonization), High Temperature (indicatively 800-1000 °C) Thermochemical conversion (pyrolysis and gasification) and Chemical conversion (transesterification and hydrocracking).

In order to select the most appropriate treatment and conversion process the following chemical and chemical-physical properties should be considered:

- Chemical composition (proteins, carbohydrates, lipids, hemicelluloses, cellulose, lignin, hydrogen to carbon ratio, toxic substances, etc.)
- Physical state (liquid, sludge, solid)
- Physical characteristics (moisture content, particle size, ash content, etc.)
- Heating value (HV)
- Biodegradability indices

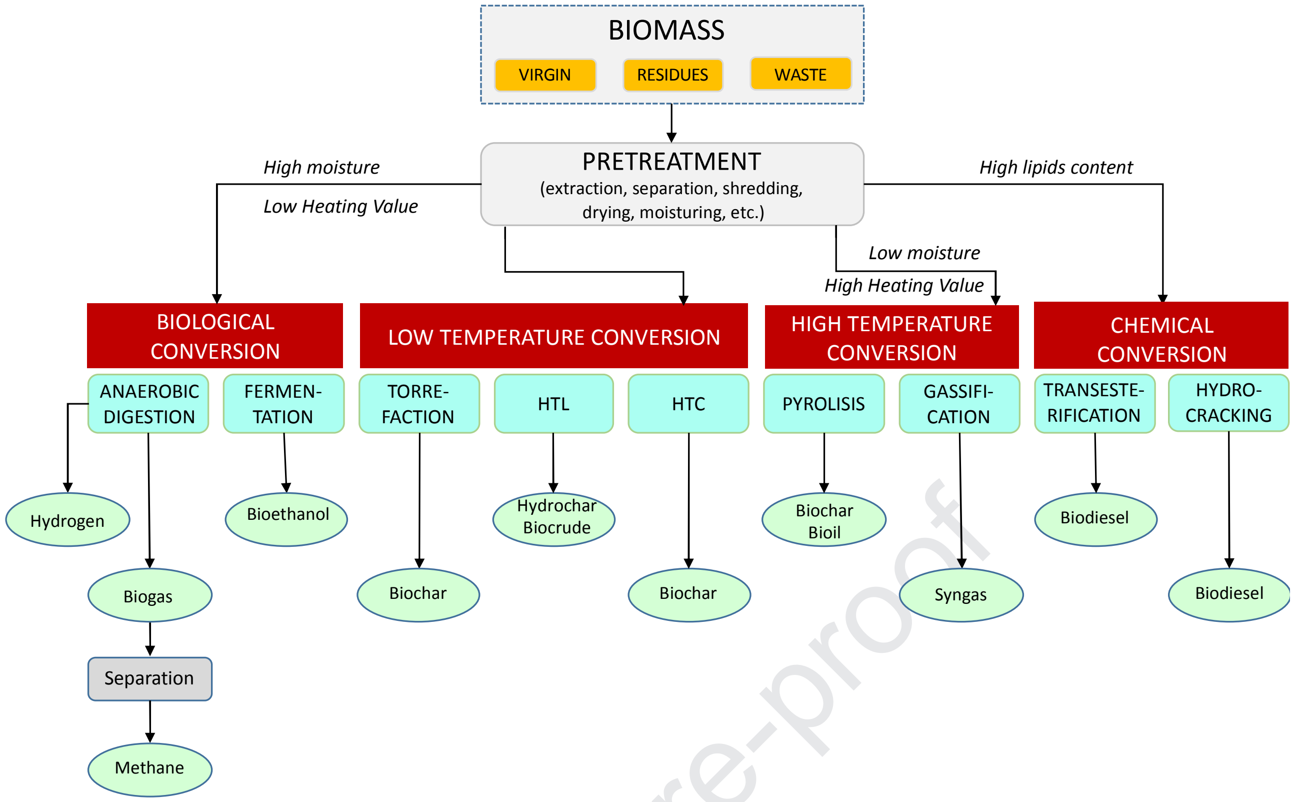

Figure 1. Scheme of possible routes for conversion to biofuel of different kind of biomass. HTL = Hydrothermal Liquefaction, HTC= Hydrothermal Carbonisation.

Generally speaking, biological processes are more suited for highly degradable waste, with high moisture content and, consequently, low heating value while high temperature thermal processes are better suited for structured biomass with high heating value. Low temperature thermal conversion (often named thermochemical conversion) can be suitable for both kind of waste. Of course water content and heating value can be controlled by pretreating the waste before conversion. Biomass with high lipids content is entitled to be converted to biodiesel.

The technologies presented in Figure 1 can be integrated in a more complex energy system, including direct combustion and considering combustibles other than biomass.

The present special issue has been contributed by selected papers from Venice 2018 (7th International Symposium on “Biomass and waste to energy”) and by normal submissions to the Journal. The 36 papers of this special issue, grouped according to the scheme in Fig.1, display several examples and experiences of different kind of biomass and processes, analyzing performances, optimization strategies, selection criteria and application potentials.

Four papers present good examples of how different kind of biomass can be generated, extracted and pretreated (corncobs, coffee husks, elephant grass, bagasse).

Nine papers focus on anaerobic digestion processes and technology, analyzing by using different kind of substrates, testing approaches, performance of various kind of reactors, influence of nitrogen on the process. Co-generation of hydrogen and methane is also considered and reported.

Four papers investigated different strategies and process modifications to optimise bio-ethanol production. The following aspects were investigated: corn stover harvest time; hardwoods pre-treatment by hydrogen peroxide-acetic acid (HPAC); low temperature pretreatment of lignocellulosic biomass by using ionic liquid; simultaneous saccharification and fermentation (SSF) of potato peel waste.

Three papers concern low temperature conversion technologies, reporting on the application of torrefaction, HTC and HTL to lignocellulosic biomass and food waste.

Six papers explored the use of high thermal technologies for conversion of MSW, vegetables and agricultural residues (palm shells, peanut shells, cashew nut shells, date palm, olive mill) into light hydrocarbons and syngas. Key design elements and process features were investigated: gas cleaning, gas catalytic synthesis, kinetic parameters (temperature, particle size, etc.).

Eight papers are addressed to analyse chemical conversion technologies (only one dealing with hydrocracking process) for biodiesel production from various substrates (animal waste fats, algae, sludge palm oil, soybean oil, waste fish oil, waste cooking oil, waste fatty acids). Process optimisation (temperature and pressure influence, ratio methanol/input, catalysts, additives) and pre-treatment options (thermal, microwave) were considered.

The last two papers present case studies where biomass to fuel conversion is combined with other conversion alternatives.

We hope that our efforts in editing this Special Issue will be appreciated by the readers.

References

[1] B. Nagel, H. Dellweg, L.M. Gierasch, 1992. Glossary for chemists of terms used in biotechnology (IUPAC Recommendations 1992). Pure Appl. Chem. 64(1), 143–168.
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