



## Effective utilization and physical conversion of biomass, and some properties of hazelnut husk

M.S.Guney

Giresun University, Department of Mechanical Engineering, Giresun, Turkey

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### Abstract

Energy consumption is steadily increasing. The environmental harmful effects of intensive energy consumption on the environment are known. It is important to ensure a sustainable life cycle. Renewable energy use and dissemination is one of the important parameters that will be purposeful. Biomass is categorized at the first places in renewable energy. It is also suitable for local supply and local solutions. Appropriate assessment to the requirements is crucial with local approaches. If this is done, it will serve the purpose more effectively. Biomass utilization generally and physical conversion methods in detail are presented in this study. These methods are classified in three main groups; physical, thermochemical, and biochemical conversion methods. Information about physical conversion was presented in subdivision and some characteristics of hazelnut husk.

*Keywords:* biomass utilization, conversion methods, hazelnut husk.

### 1. Introduction

Because of the depletion of fossil fuels and their harmful environmental effects, it is necessary to turn to alternative and renewable energy sources and to search for equivalent fuels. Therefore, Exploring new energy resource has already become the focus of international competition and strategic commanding point [1]. Biomass is the most abundant renewable resource. lignocellulosic biomass is considered as an alternative raw material for the production of valuable chemicals and even fuels [1-4]. Biomass generally consist of various resources such as agricultural residues, energy crops, forest resources, organic waste (such as municipal and industrial), algae, etc.[5]. According to the researchers, even fumes from landfills, are called biomass energy sources [6]. The diversity of biomass resources requires the development of multiple conversion technologies. The presence of a wide variety of raw materials leads to diversification in physical and chemical properties. Transformation technologies must be able to handle all of these challenges effectively [7]. On the other side, limited by the compact structure of biomass itself, various conversion technologies are necessary to obtain high-value products [8]. Trees, woody agricultural and forest residues are lignocellulosic biomasses, mainly composed of cellulose, hemicellulose and lignin. Cereals and wastes, on the other hand, contain a lot of starch and have different components [8].

The use of lignocellulosic biomass requires the separation of different components [8]. Generally, biomass emerges in solid, liquid and gas phase. It can also be found as a multi-phase structure in the form of combinations, such as in municipal wastes and animal wastes. In addition to these, lignocellulosic structures known as single-phase (solid), however, have non-structural moisture. It is necessary to move away this moisture at a certain amount from biomass beforehand. In this context, biomass conversion systems should take all these factors into consideration and provide the optimum solution.

The widespread use of renewable energies requires global thinking and local approaches. It is important to bring solutions in close proximity to local needs. For this purpose, biomass conversions constitute one of the most significant instruments. Biomass is confronted in a wide variety of structures. Furthermore, the conversion targets and intended usage purposes are also different. The issue is gaining importance which goal is best achieved by which most appropriate method. By adopting the systematic approach mentioned in this study, classification and examination of the methods, and explanations of the usage places are carried out respectively. There is supported with some comprehensive and distinctive informations on the subject additionally.

## 2. Conversion methods and physical conversion

Conversion of biomass is practicable and realizable into industrial materials, biofuels, heat and power, and biogas [9]. The conversion of biomass to energy (also called bioenergy) encompasses a wide range of different types and sources of biomass, conversion options, end-use applications and infrastructure requirements. The conversion of biomass into energy includes to take under the spotlight and examine of biomass resources in a wide variety of styles and types. conversion options, end-use applications and infrastructure requirements [10]. Biomass conversion methods can be basically divided into three categories such as Physical, Thermochemical, Biochemical. [11] Among these methods, the physical conversion is given detailed in the following sections with classification.

### 2.1. Physical conversion

Biomass conversion Technologies refer to the modification and processing of biomass to produce high-value products. The main products of physical conversion Technologies include sheets, construction materials, and lignocellulosic composites [12]. Furthermore, it can be useful comparing the social, economic, and environmental aspects of utilizing woody biomass for energy by direct burning and burning wood pellets [13].

#### 2.1.1. Firewood

This involves the incineration of agricultural waste and materials such as wood for direct heating without further processing or for the purpose of obtaining process heat. The suitability for direct combustion also requires reducing the amount of moisture, ie drying the biomass.

Firewood is a classic energy source, is still important household energy source in many developing countries. To convert raw materials (wood, husk, agricultural wastes, etc) to firewood, it is cut into the desired length and thickness according to furnace dimension and purposes [14].

Woody materials used as fuel can be compared with their heating values. Mean heating values of various agricultural wastes vary between 15 MJ / kg and 23 MJ / kg. [15]. In addition, calorific value analyzes and estimated regression analysis methods can be used for determining of heating value of different materials which can be used as biomass. It seems that calorific values of some solid agricultural residues are around 20 MJ / kg. [16]

#### 2.1.2. Pelletizing

Agricultural and woody residues have low heating value per unit volume and high transportation and storage costs when used in as received condition; these difficulties can be largely overcome through densification which is an effective approach for using residues efficiently. Densification offers an opportunity to make biomass easier to handle and transport. If the (agricultural) residues have a low heating value per unit volume and therefore are used in their original condition, high transport and storage costs will arise. These challenges can be largely overcome by Increase the density and feature improvement, which is an effective approach to using residues efficiently. Concentration provides an opportunity to facilitate the transport effectively [17].

Biomass pellets are gaining importance in many countries [18]. The densification of biomass improves its handling, transport and storage conditions, and reduces its moisture content, increasing the calorific value . Moreover, the densified biomass (pellet) has homogeneous characteristics, which make it a convenient biofuel for residential use in automatic furnaces and boilers [18]. Pelletization can be described as an agglomeration process that converts fine powders or granules of bulk drugs and excipients into small, free-flowing, spherical or semispherical units. Pellets range in size, typically, between 0.5 mm and 1.5 mm [19, 20].

In some countries, electrical energy is used for domestic heating small houses. Electrical energy is a highly qualified energy and is easy to convert into other forms of energy. Heating energy is covered by low-quality energy, the process technology is easy and the environmental impact is extremely low. Therefore, providing domestic heating by burning pellets offers an important Alternative to electrical heating [21]. Nowadays, wood is by far the most widely used raw material for pellet production. However, due to the increasing demand of pellets for energy and non-energy purposes, investigation on alternative raw materials such as bark, logging residues, agricultural residues and energy crops is needed [22].

#### 2.1.3. Particleboard

The raw material demand of the global forest products industry increases annually. On the other hand, industrial wood production from the natural

forests has been declining, and that forces the forest industry to find some other agro-residues and lignocellulosic biomass as an alternative raw material for industrial production [23].

Particleboard is a composite panel that is valued for its consistency and ability to be engineered for specific applications. These properties have caused particleboard to be widely used to manufacture countertops, door cores, floor underlayment, and furniture. Particleboard is manufactured from wood residues (or other biomass such as lignocellulosic agricultural wastes) that are generated as a coproduct of lumber milling. Particleboard is also widely regarded as a sustainable material because it utilizes wood residues from other manufacturing processes that might otherwise be wasted [24].

Production of particleboard based on lignocellulosic residues is characterized as a sustainable alternative, bringing benefits not only to chain-generating waste, but to consumer market of this product [25]. Classification is made by the method of manufacturing, surface condition, shape, and density [26]. Fibreboard is a material produced from lignocellulosic fibers with the use of heat and pressure. Fiber bindings can be achieved as a result of full and natural adhesion properties of the fibres or further by the addition of a binder ( glue) [27]. According to density, fiberboard (wet) can be classified as follows:

Hard boards (HB)  $\geq 900$  kg / m<sup>3</sup>,  
Semi-hard boards (MB) 400 and 900 kg / m<sup>3</sup>.

### 3. Results and discussion

Due to its size and degradation, biomass is difficult to transport and store without processing. Therefore, it is more reasonable to use biomass in its natural state only in the areas where it is produced. In this regard, biomass can be effectively used in or near regions where a balanced biomass supply and demand exists [31]. On the other hand, if the biomass

### 4. Conclusion

Biomass is a significant renewable resource. Agricultural residues are not included in food chains. Therefore, it is more preferable to evaluate them as biomass. It is essential to use appropriate conversion, forming and shaping methods with low energy

### References

Porous boards (SB) 230 kg / m<sup>3</sup> ÷ 400 kg / m<sup>3</sup>

According to density, fiberboard (dry) can be classified as follows [28]:

Low density fiberboard (LDF) - less than 650 kg / m<sup>3</sup>.

Middle density fiberboard MDF - from 650 to 800 kg / m<sup>3</sup>.

High density fiberboard HDF - over 750 kg / m<sup>3</sup> [28].

Moreover, good quality thermal insulation material from biomass is possible. Thermal insulations made of biomasses like agro-residues, forest residues, etc., are developing very fast recently. often named "bio-based insulations" or "bio-insulations" Agricultural straws, such as wheat, corn or rice straws, in raw form (e.g., straw bales) have been used as building insulation materials for a long time due to their hollow structure, low cost, low density and low thermal conductivity [29].

### 2.2. Husk of hazelnut

The idea of obtaining energy from biomass and using it as an additive with appropriate conversion methods is increasingly being used at every platform and opportunity. Husk of hazelnut is an agricultural residue with significant amount of 120,000 tons per year approximately. Hazelnut husk has an average composition of 40% carbon, 5% hydrogen, 1% nitrogen, 45% oxygen, 5 to 8% ash and negligible amount of sulfur. When the chemical structural composition is examined, it shows around 35% cellulose, 20% hemi cellulose and 35% lignin. Heating value is 18,35 MJ/kg [30].

is converted to a more portable form, such as densified pellets or liquid fuels, it can be used in remote areas. In addition, biomass can be used as diversified material such as biomass, food, feed, fiber, raw material, forest products, fertilizer and fine chemicals or energy [32-34].

consumption and environmental adverse effects. Hazelnut husk creates a significant amount as agricultural residue. It also shows remarkable physical and fuel properties such as heating value.

- [1] Jiang, Z., Hu, C. Selective extraction and conversion of lignin in actual biomass to monophenols: a review. *Journal of Energy Chemistry* 2016; 25(6): 947-956.
- [2] Habibi, Y., Lucia, L.A., Rojas, OJ. Cellulose nanocrystals: chemistry, self-assembly, and applications. *Chemical reviews*, 2010; 110(6): 3479-3500
- [3] Chen, G. Q., Patel, MK. Plastics derived from biological sources: present and future: a technical and environmental review. *Chemical reviews*, 2011; 112(4): 2082-2099.
- [4] Gallezot, P. Conversion of biomass to selected chemical products. *Chemical Society Reviews*, 2012; 41(4): 1538-1558.
- [5] [https://energy.gov/sites/prod/files/2016/07/f33/conversion\\_factsheet.pdf](https://energy.gov/sites/prod/files/2016/07/f33/conversion_factsheet.pdf)
- [6] <https://www.nrel.gov/workingwithus/re-biomass.html>.
- [7] <https://energy.gov/eere/bioenergy/conversion-technologies>
- [8] Chen H., Wang L., *Technologies for Biochemical Conversion of Biomass*, Metallurgical Industry Press by Elsevier London 2017.
- [9] Davis, S.C., Hay, W., Pierce, J. Biomass in the energy industry: an introduction, *Biomass handbook*, 2014, [www.bp.com/energysustainabilitychallenge](http://www.bp.com/energysustainabilitychallenge)
- [10] McKendry, P. Energy production from biomass (part 2): conversion Technologies *Bioresource technology*, 2002; 83(1): 47-54.
- [11] Agbontalor, EA. Overview of various biomass energy conversion routes. *American-Eurasian J of Agricultural and Environmental Science*, 2007; 2(6): 662-671.
- [12] Chen, HZ., Wang, L. Conversion technology and utilization of biomass energy (VIII): principle and application for biomass bioconversion technology. *Biomass Chemical Engineering*, 2008; 4: 22-28.
- [13] Nishiguchi, S., Tabata, T. Assessment of social, economic, and environmental aspects of woody biomass energy utilization: Direct burning and wood pellets. *Renewable and Sustainable Energy Reviews*, 2016; 57: 1279-1286
- [14] The asian biomass handbook, The Japan Institute of Technology, [http://www.jie.or.jp/biomass/AsiaBiomassHandbook/English/All\\_E-080917.pdf](http://www.jie.or.jp/biomass/AsiaBiomassHandbook/English/All_E-080917.pdf).
- [15] Gravalos, I., Xyradakis, P., Kateris, D., Gialamas, T., Bartzialis, D., Giannoulis, K. An experimental determination of gross calorific value of different agroforestry species and bio-based industry residues. *Natural Resources*, 2016; 7(1): 57-64.
- [16] Moka, VK. Estimation of calorific value of biomass from its elementary components by regression analysis, PhD Thesis, National Institute of Technology, Rourkela, 2012.
- [17] Karkania, V., Fanara, E., Zabaniotou, A. Review of sustainable biomass pellets production—A study for agricultural residues pellets' market in Greece. *Renewable and Sustainable Energy Reviews*, 2012; 16(3): 1426-1436.
- [18] García-Maroto, I., García-Maraver, A., Muñoz-Leiva, F., Zamorano, M. Consumer knowledge, information sources used and predisposition towards the adoption of wood pellets in domestic heating systems. *Renew Sustain Energy Reviews*, 2015; 43: 207-215.
- [19] Ghebre-sellassie, I. Pellets: a general overview. In: GhebreSellassie, I, (Editor). *Pharmaceutical pelletization technology*. New York: Marcel Dekker; 1989. p. 1–15.
- [20] Muley, S., Nandgude, T., Poddar, S. Extrusion–spherionization a promising pelletization technique: In-depth review. *Asian J. of Pharmaceutical Sciences*, 2016; 11(6): 684-699.
- [21] Fiedler, F. The state of the art of small-scale pellet-based heating systems and relevant regulations in Sweden, Austria and Germany. *Renewable and Sustainable Energy Reviews*, 2004; 8(3): 201-221
- [22] Puig-Arnavat, M., Shang, L., Sárossy, Z., Ahrenfeldt, J., Henriksen, UB. From a single pellet press to a bench scale pellet mill—Pelletizing six different biomass feedstocks. *Fuel processing technology*, 2016; 142: 27-33..
- [23] Guler, C., Büyüksarı, Ü. Effect of production parameters on the physical and mechanical properties of particleboards made from peanut hull (*Arachis hypogaea* L.) *BioResources*, 2011; 6(4): 5027-5036
- [24] Anonymous 1, Environmental Product Declaration Particleboard, <http://www.awc.org/pdf/greenbuilding/epd/1311.pdf> 27.02.2017
- [25] Da Silva Bertolini, M., do Nascimento, MF., Blecha, KA., Lahr, FAR. Eco-panels based on wastes from urban trees and castor oil polyurethane resin. *Int. Journal of Agriculture and Forestry*, 2013; 3(1): 12-15.
- [26] [http://www.iso.org/iso/catalogue\\_detail.htm?csnumber=5172](http://www.iso.org/iso/catalogue_detail.htm?csnumber=5172) 27.02.2017
- [27] [http://sppd.pl/en/plyty-pilśniowe-\(metoda-](http://sppd.pl/en/plyty-pilśniowe-(metoda-)

- mokra).html 27.02.2017
- [28] <http://sppd.pl/en/mdf,-ldf,-hdf.html>
- [29] Liu, L., Li, H., Lazzaretto, A., Manente, G., Tong, C., Liu, Q., Li, N. The development history and prospects of biomass-based insulation materials for buildings. *Renewable and Sustainable Energy Reviews*, 2017; 69: 912-932.
- [30] Gürdil, G., Demirel, B., Baz, Y., Demirel, C. Pelleting hazelnut husk residues for biofuel, International Conference on Trends in Agricultural Engineering, 7-9 September 2016, Prague, Czech Republic.
- [31] Yokoyama, S., Matsumura, Y. (2008). The Asian biomass handbook: a guide for biomass production and utilization. Thermochemical conversion of biomass, 1st (Ed) part, 4, 71, [http://www.jie.or.jp/biomass/AsiaBiomassHandbook/English/All\\_E-080917.pdf](http://www.jie.or.jp/biomass/AsiaBiomassHandbook/English/All_E-080917.pdf)
- [32] Kaygusuz, K., Guney, MS., Kaygusuz, O. Renewable energy for rural development in Turkey. *Journal of Engineering Research and Applied Science* 2019; 8(1) 1109-1118.
- [33] Kaygusuz, K., Güney, MS., Kaygusuz, O. Renewable energy for rural development in Turkey. *Journal of Engineering Research and Applied Science* 2018; 7(2) 886-895.
- [34] Kovalyshyn, S., Kaygusuz, O., Guney, MS. Global energy demand and woody biomass. *Journal of Engineering Research and Applied Science* 2019; 8(1) 1119-1126.