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Recycling of Biomass Combustion Ashes

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Abstract

Biomass is one of the most important renewable energy sources in the energy industry. It is anticipated that burning biomass will supply 33–50 percent of the world's energy needs by 2050. Similar to how biomass burns, conventional fuels also produce fly ash and other combustion byproducts. As a result, interest in biomass as an energy source is also growing, as is the annual production of ash, a byproduct of combustion. According to estimates, the burning of biomass has the potential to produce approximately 476 million tons of ashes annually. The amount of ash produced by heating wood ranges from 0.4 to 3.9% of the dry fuel mass, while the dry wood mass's calorific value typically falls somewhere in the 18.5 MJ kg 1 range. However, it is particularly challenging to identify biomass ash due to the wide range in chemical composition between biomass and combustion technology. Additionally, despite the fact that it may contain combustible substances like polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs), as well as toxic compounds that are harmful to the environment like heavy metals, this waste is a valuable ingredient that can be utilized in fertilizers. It contains calcium (Ca) and potassium (K) among other nutrients and microelements. The majority of PAHs and VOCs are produced when coal and wood are incompletely burned in unstable low-power boilers. However, incomplete combustion may also contain substances that are formed as a result. However, it is essential to keep in mind that a number of analyses must be carried out before the fly ash can be utilized as an additive to building materials or fertilizer for cultivation in a variety of industries (such as zeolite synthesis, the recovery of rare earth metals, or the production of plastic). Utilizing combustion byproducts is the goal here. Tests should be conducted on organic compounds, chlorides, heavy metals, sulfates, micro- and macroelements, grain and phase composition, and other factors. Instead of being disposed of in landfills, where it will lose its valuable properties, such ash should be used for agriculture and land reclamation if its pollution levels are low. This review aims to discuss the characteristics of biomass combustion ashes produced in Poland and around the world, the factors that influence their composition, and the possibilities for their reuse in various industries and the environment.

Keywords: Plant Biomass; Fly Ash; Combustion

Introduction

A significant portion of Poland's total industrial waste is made up of combustion byproducts from the production of heat and electricity. According to the literature, between 900 and 1000 million tons of energy waste are produced annually worldwide. The European Union (EU) produces 100 million tons annually, while the United States alone produces 130 million tons annually. Worldwide and within the EU, a significant amount of generated energy is wasted. In December 2018, the revised Renewable Energy Directive (Directive (EU) 2018/2001) became effective as part of the Clean Energy for All Europeans package. According to the new directive, renewable energy must account for at least 32% of the final energy consumption in the Union by 2030 **[1,2]**. A clause states that this goal can be increased to 14 percent of transportation energy from renewable sources by 2030 and 2023. Not only for economic and technological reasons but also specifically for eco-development that is sustainable, the energy industry has pioneered the use of biomass as a renewable energy source. Additionally, because the amount of CO_2 released during combustion is comparable to the amount that plants have previously absorbed from the atmosphere, it is considered a carbon-neutral fuel.

At the moment, the most promising renewable energy product is biomass. In some nations, municipal waste, which includes waste from residential and commercial as well as public services, is also referred to as biomass. Between 112 and 220 billion tons of biomass are produced annually worldwide, according to literature: biomass with an energy potential of 1.2 to 3.1 billion tons, consisting of approximately 3 billion tons of forest residue and 1.1 billion tons of municipal solid waste. The report predicts that biomass combustion will account for 33 to 50 percent of the world's energy reserves by 2050. However, as biomass combustion increases, so does the annual production of waste ash. At the present time, it is anticipated that the combustion of biomass will annually produce approximately 476 million tons of ash **[3,4]**.

The unique chemical composition of the ash is determined by the characteristics of the biomass and the conditions under which it was burned. The majority of this trash ends up in piles or in landfills. It can also be stored, but if stored in unsuitable conditions, it may lose its quality. Because valuable components could be used to improve the properties of soil and fertilize plants, removing biomass ash from landfills is bad for the environment, according to Jacobson and others **[5]**. Therefore, it makes sense to use the ash from burning biomass for a variety of purposes, including farming, restoring degraded land, safeguarding the environment, producing plastics, zeolites, and recovering rare earth metals. However, the application of the ash is determined by its physicochemical properties. The Minister of Agriculture and Rural Development's Regulation of 18 June 2008 on the implementation of specific provisions of the act on fertilizers and fertilization specifies the permissible metal content in mineral fertilizers, including ashes from biomass combustion **[6-8]**.

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Discussion

According to this regulation, biomass is agricultural and forestry products that have been burned to extract their energy. Plant materials can make up all or some of it. Plant waste from agriculture, forestry, and the food industry are also included in biomass. Typically, agricultural plant waste and forest biomass are used in heating and combined heat and power plants. The majority of Poland's biomass is comprised of waste wood, sawdust, shavings, bark, and wood chips. The majority of Poland's biomass is also made up of other straws, like cereal, sunflower, and rapeseed straw. Pellets are made, among other things, from agricultural processing and straw or sunflower hulls, which are also used to generate heat and energy. Examples include oilseed stalks, cereal coffee pomace, seeds and husks from fruit processing, and corn. Energy crops include poplar, birch, and alder plantations, Pennsylvanian mallow, miscanthus, and reed canary [**9,10**]. The variety of fly ashes produced by biomass combustion necessitates careful handling. In addition, the type of material from which they were obtained and information regarding their chemical composition should be used to support the use decision.

Conclusions

The possibility of making use of the ashes that are produced when biomass is burned has been the subject of numerous arguments and comments, both in support of and against this idea. When disposing of the ashes from biomass combustion, it is essential to keep in mind that the most effective technological methods and legal regulations should be adhered to while still maintaining economic efficiency. Biomass ashes have distinct properties and compositions because of the various raw materials used and combustion conditions. The production of plastics, the recovery of rare earth metals, and the synthesis of zeolites and geopolymers are all potential new areas of development.

However, in recent times, the ashes that are produced when biomass is burned have been increasingly utilized as a material for methods of remediation and reclamation and to enhance the quality of agricultural soil. The possibility of binding them together with ash is also being considered when making fertilizers from other wastes like sewage sludge. Ashes appear to have the potential to enhance plant growth and yield. However, utilizing them safely for environmental purposes necessitates modifying legal regulations, careful consideration of technical and environmental aspects, and extensive knowledge based on research results.

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