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The study of mechanical properties of natural polymers in the compacting process

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Abstract

The paper presents a methodology of testing the mechanical properties of fibrous materials belonging to the group of natural polymers. The research methodology includes the process of aging in a controlled humidity atmosphere using a climatic chamber. The paper presents the results of the degree of compaction of the shredded coconut material and sediment post-fermentation fiber as a function of humidity. We have also studied the friction coefficient of the compacted material in depending on the influence of temperature. The results are the basis for determining the parameters of agglomeration of the tested materials. In addition results are essential to determine effective forces of compaction which are used for the formulation of construction of machines for this purpose.

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Keywords: natural polymers; mechanical properties; relative density; coefficient of friction; degree of compaction;

1. Introduction

In highly developed countries biomass covers about 80% of the total energy consumption. With a growing demand for alternative fuels, especially to cover the daily needs of households, consideration is given to various waste materials of different origin [1,2].

There are a number of ways to extract energy from biomass, including burning, gasification, pyrolysis, anaerobic fermentation, hydration and aerobic fermentation [3]. The methods and technologies for extracting thermal and electrical energy from biomass have been described in numerous articles [4]. Biomass densification is one of the key parts of these processes [5,6]. The benefits of biomass densification include increased amount of energy per unit volume and improved efficiency of storage and transport. Other benefits include improved efficiency of burning, resulting in reduced emission of solid particles and improved parameters of biomass fuel including uniformity of geometric parameters, increased bulk density and better durability [7-9].

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The features of biofuels obtained by mechanical densification (pelletizing) of grass, wood, straw, leaves, stems and biofuels obtained by combining the different biomass types can be found in a number of papers [7-16]. This paper presents the results of research of the mechanical properties of mechanically densified digestate and coconut husk - two biomass materials. The test method was developed specifically for the present research.

2. Description of the tested materials

The tested materials were digestate from bio-gas plant (Fig. 1a) and coconut husk from Vietnam (Fig. 1b).

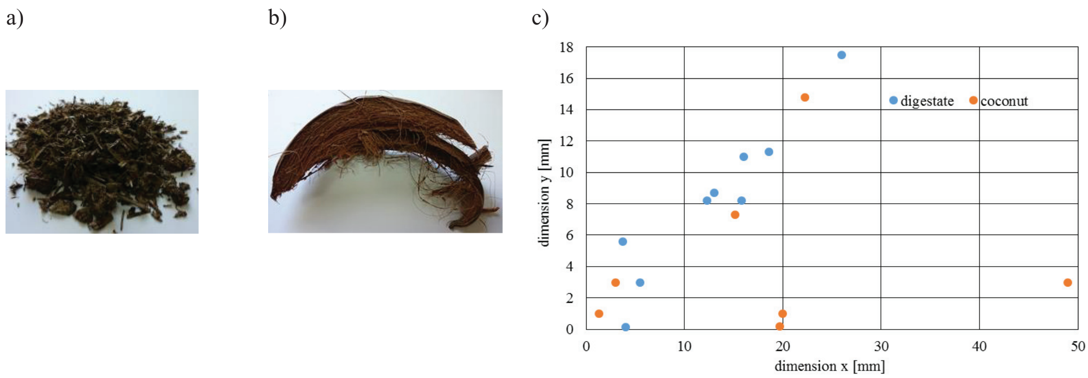

Fig. 1. Parameters of the tested materials: a) digestate from bio-gas plant, b) coconut, c) particle size of the two tested materials.

The tested digestate was a granular material with particle size distribution shown in the chart in Fig. 1c. The coconut material was shredded coconut husk with particle size distribution shown in the chart in Fig. 1c.

2.1. Test method and procedure

The test method and procedure are presented in the following block diagram (Fig. 2) [6,7].

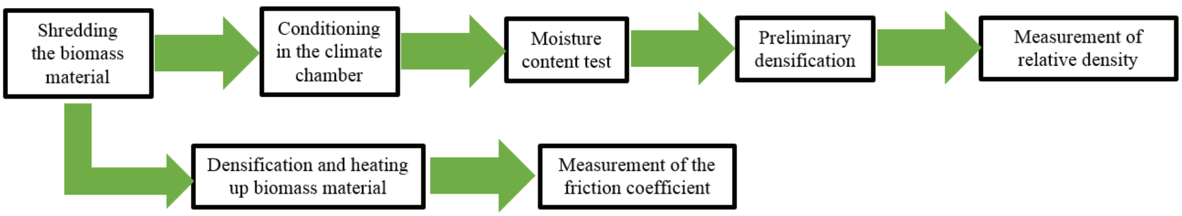

Fig. 2. Experimental research method.

Before placing in the climate chamber (2) (Fig. 3) the material was shredded if and as required for placing inside the cylindrical die for the purpose of its preliminary densification (Sec. 2.3). The samples prepared in this way were placed in the climate chamber (2) (Fig. 3) for conditioning. The moisture content of the conditioned samples was determined with a moisture balance (3) (Fig. 3) after which the sample was subjected to preliminary densification. Then the die including the sample material and ram were fitted in the strength tester (1) (Fig. 3) to measure the relative density. Simultaneously, another sample of the same material was tested to determine the coefficient of friction in contact with steel plate surface (Sec. 3.1). To this end the shredded material was placed inside the die,