



INVESTIGATIONS OF THE PLANT NANOFIBERS FOR THE PRODUCTION OF MODIFIED PLATE MATERIALS

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Abstract

This article analyzes modern trends of plant origin waste recycling. Conducted research of receiving cellulose nanofibers offer significant prospects for further development of technologies for processing waste into useful products. In this connection, it is required to determine the properties of obtained nanofibers and their optimal ratio to produce a product with specified physical and mechanical, operational and economic characteristics.

Keywords: *Cellulose, nanofiber, plant, plate, technology, waste.*

In today's world there is a large amount of waste of plant origin, requiring deep processing. Large world amounts of wood and agricultural plants usage as raw materials in furniture, chemical, food processing industries, construction, agriculture, lead to the formation of large amounts of waste. This waste usually has zero or even negative cost. There is no doubt in negative effect of processed products of plant origin raw materials on the environment, not only around the industrial enterprises, but also in the surrounding cities. Decomposition of industrial waste of this type, the cases of spontaneous combustion, emission of harmful substances of them are cause of air, soil, seas, rivers and lakes pollution.

Chemical composition, structure and properties of products of processing in most cases are determined by cellulose $(C_6H_{10}O_5)_n$ contained in them. Cellulose is one of the most abundant natural biopolymer in the world, which is renewed, and biodegradable [1]. There are many methods and ways of processing of plant waste into useful products. In Europe, the United States of America, China and some South American countries over thirty years ago the production of biofuels in the form of pellets, briquettes from raw materials of plant origin has been started. These technologies are more interesting to the countries where there are sufficient mineral reserves of energy resources that are oil and natural gas. However, the available techniques and equipment for the production of biofuels have significant disadvantages: lack of depth of processing, the need for retrofitting of existing systems to allow use of biofuels as an energy source, in some cases, low calorific value.

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Currently scientific research and practical development of processing of plant waste into other products are in great interest. This way also has good prospects for all countries with large reserves of biomass. The present level of analytical instruments, test equipment, mathematical software makes it possible to obtain very accurate information of any materials, their properties, the nature of interactions of plant waste components.

The recent world-class research has shown that extracted from cellulose nano- and microfibers have higher mechanical properties than single fibers [2]. This type of fiber, by number of scientists, is offered to use for strengthening some of polymeric materials [3, 4, 5].

As a rule, to obtain the cellulose fibers and fiber aggregates there are two main ways: chemical - with the help of a strong acid hydrolysis, as well as mechanical. The method of mechanical treatment is divided into a high-intensity ultrasonic treatment, homogenizing process under high pressure [6], fragmentation processing at high pressure [7] as well as microfluidizer processing [8]. The product obtained by chemical way is called cellulose whiskers or cellulose nanocrystals. The product obtained by chemical method is called microfibrils of cellulose or microfibrillae.

In recent years studies of nanocomposites derived from cellulose are intensively developed. This is due to environmental clean technologies and possibility of increasing the strength of materials. French researchers have used some natural cellulosic fibers, treated with high-power ultrasonic in the manufacture of polyvinyl acetate at room temperature, and found that when adding cellulose fiber, tensile modulus and strength of polyvinyl acetate are increased. However, the dispersion of cellulose was not completely uniform in the matrix section, and there were some gaps between the polymer matrix and fibrils [9].

Preliminary studies of Chinese scientists made it possible to identify micro / nano-fibrils of cellulose from poplar wood and rice straw using enzymes and high-intensity ultrasonic, respectively. Nanocomposites were obtained by combining micro/nano fibers and polypropylene. The results showed that the best compatibility of micro/nano fibers and polypropylene is achieved by adding binding agent in the composites [10].

However, the obtained world present results in release of micro and nanofibers from raw materials of plant origin do not allow their use for production, because there is no fundamental knowledge on the relationship of modification methods of natural cellulose waste and technologies for getting new materials with improved properties. The solution to this problem is assumed by the authors in further theoretical and practical research.

As a rule, considered waste is required to expose to dehydration, drying in order to impart its final properties of raw materials for further processing. Conducted research to determine the patterns of heat and mass transfer during drying process of capillary-porous disperse materials of plant origin have yielded positive results [11].

Mathematical models of heat and mass transfer have been obtained taking into account rather complex hydrodynamics process. This allowed creating automated industrial equipment control systems, to analyze patterns of moisture removal under the influence of temperature field during changing external influences, to identify ways of intensification of the drying process of various fibrous materials of plant origin and search for reserves to increase their energy efficiency.

Research, carried out in the world, and accumulated experience in studying the properties of nanofibers of plant origin allow us to conclude the inadequacy of our knowledge and understanding of cellulose sources as a material for manufacturing products and renewable energy sources [1].

Unfortunately, at present, there is no fundamental research on identifying dependences of properties of modified plate materials and bio-fuels, taking into account the properties of

nanofibers of plant origin and modes of treatment. Such knowledge may allow the rational utilization of all types of waste of plant origin.

It is obvious that such raw material has not the same properties and chemical composition, which determines its industrial value. These characteristics depend on the origin of nanofibers (wood, plant species). So it is required to solve the problem of determining the optimal proportions of various nanofibers in finished products.

Modern level of development of industry and equipment requires precise control accuracy, and setting required parameters in the automatic mode in the main fleet of involved machines and devices during the objective changes in external influences. Only such an objective management makes it possible to reduce energy consumption and security processes, maximum productivity, obtaining high quality products. To solve such a task is impossible without accurate knowledge of the nature of interactions between the properties of raw materials, the ratio of nanofibers of different origin and properties of the finished products. Achieving this goal it is planned to continue the joint Chinese-Russian scientific-practical project aimed at getting plate materials with the use of nanofibers produced from wood and agricultural plants waste.

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