PRODUCING ENVIRONMENTALLY ENVIRONMENTAL PAPER PRODUCTS FROM INDUSTRIAL HEMP

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Industrial hemp as a raw material for pulp and paper production has a number of advantages. One advantage is that hemp produces a high fiber yield per hectare of crop area compared to traditional sources such as wood. In addition, hemp fibers are stronger and more durable than wood fibers, resulting in higher quality paper products. Hemp is also a fast-growing crop that can be grown at a lower cost and with less environmental impact than traditional wood raw materials.

Keywords: industrial hemp, refining, paper products, ecology.

Currently, wood is the main raw material for the global pulp and paper industry. However, this is a relatively new raw material for paper production. Historically, paper was made exclusively from non-wood plant fibers. The first true production of paper is attributed to Cai Lun in 5 AD in China. The first paper was made from textile waste, old rags and used fishing nets, which consisted of industrial hemp fibers and Chinese nettle (ramie) [2]. However, in the late 17th century, wood became the predominant source of raw material and remains so to this day.

Currently, existing wood resources are insufficient to meet the steadily growing demand for paper. As a result, a need arose for affordable alternative raw materials. Non-wood plants can become this again.

The use of non-wood raw materials in the production of paper products is relevant for the following reasons:

- Expansion of the raw material base. This will reduce dependence on very limited wood resources, which will contribute to the conservation of forests and biodiversity;
- Environmental friendliness. Non-wood raw materials can be obtained from agricultural waste (rice straw, bagasse), industrial crops (industrial hemp, flax) and naturally growing plants (bamboo, sisal);
- High quality of finished products. Some types of raw materials (for example, industrial hemp) have high fiber strength, which makes it possible to produce durable paper;
- Economic benefit. The use of non-timber raw materials can create economic opportunities in regions where wood resources are limited or unavailable. This could support the development of local industries based on agricultural waste or other non-wood fiber sources [1].

For thousands of years, hemp (Cannabis sativa L.) has been one of the most common species valuable to humans. The genus Cannabis originated in Central Asia and then spread to different regions of the world. The plant's rapid growth in both temperate and tropical climates, as well as the enrichment of the soil after each crop, has attracted many people to its cultivation [3].

Common hemp (Cannabis sativa) is an annual bast-fibrous plant of the genus Cannabis of the hemp family (Cannabaceae). The hemp stem consists of two parts: the outer layer - bast fibers (30%), the inner layer - hurd (70%).

Hemp fiber has great strength and does not undergo noticeable changes when in contact with water; it is widely used in the manufacture of ropes, canvas, fire hoses and many other products.

The great advantage of cultivating hemp, compared to other easily renewable cellulose-containing sources of raw materials, is the high yield of biomass in a fairly short period of time - almost 3.5 months, with a growth rate of about 50 cm/month. From a sown area of 1 hectare, it is possible to obtain about 5-6 tons of cellulose per year. This crop is unpretentious to climatic conditions, has increased drought resistance, high resistance to microbes and pests, and is also characterized by a low need for nutrients and pesticides.

Due to the high content of cellulose in hemp biomass, it is widely used in the production of valuable and thin grades of paper [4, 5].

The basis of paper products is cellulose. Due to its structure, unlike wood raw materials, industrial hemp does not require chemical treatment. Hemp paper can be produced by refining without the use of chemical treatment.

Of particular interest is knife refining of high consistency mass. Compared to refining low consistency mass, it has the following advantages:

- Slight shortening of fibers;
- Increase in the specific surface area of fibers and, as a consequence, an increase in the ability of fibers to form interfiber bonds;
- Paper strength indicators increase;
- The productivity of refining equipment increases and the specific energy consumption decreases [6].

Pre-treatment of raw materials is carried out by refining bast fibers in a hammer crusher and then soaking them.

Refining is carried out on a laboratory disk mill with a fibrous mass consistency of 10%, a rotor speed of 2500 rpm and an interblade gap of 1.5 mm [7]. To compare the physical and mechanical properties, two different disc mill blade sets were used: with a circular shape of knives and their uniform distribution and a traditional disc with a rectilinear shape of knives.

The properties of paper castings are compared in terms of breaking length. This indicator is the most widely used strength characteristic of paper. It characterizes the internal strength of paper products and depends on factors such as strength, fiber length, and interfiber bonding forces.

Figure 1 shows the indicators of the breaking length of paper castings after refining the fibrous mass in a disk mill using a disc with a circular shape of knives and their uniform distribution and a disc with a rectilinear shape of knives.

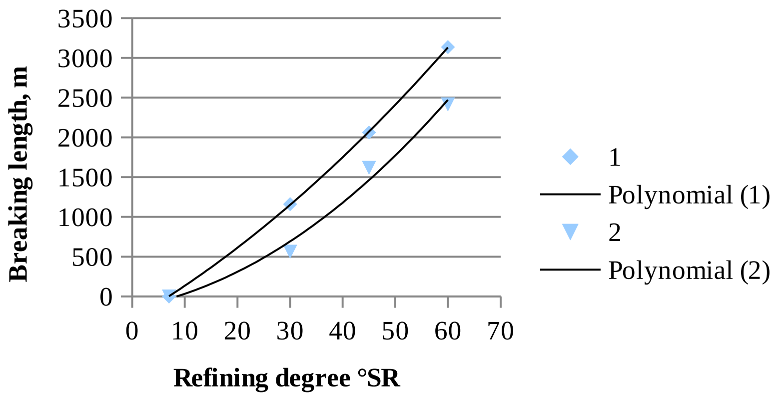

Figure 2 – Dependence of the breaking length on the degree of refining: 1 – disc with a circular shape of knives and their uniform distribution; 2 – traditional disc with straight knives

As can be seen from the figure, the qualitative characteristics have identical values, but the quantitative values differ and, regardless of the type of headset, the indicators increase.

The breaking length values for a disc with a circular blade shape are higher than for a disc with a straight blade shape. This may be explained by the fact that when using a disc with a circular blade shape, the fibers are subject to less shortening than when refining on a disc with straight knives. In addition to less shortening, the fibers fibrillate more due to the design features of the refining headset, which in turn increases the interfiber bonding forces [8].

Based on the above, we can draw the following conclusion: the breaking length indicator has the same qualitative character, but at the same time, the quantitative values are higher for castings obtained after refining in a disk mill on a set with a circular shape of knives and their uniform distribution. This effect is achieved due to better fiber fibrillation and less shortening.

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