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PROCESSING OF WOOD WASTE FROM THE RUSSIAN TIMBER INDUSTRY COMPLEX INTO SECONDARY PRODUCTS

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During wood processing, associated waste is generated, during which there is a need to process such waste into secondary products for their further use. The purpose of this article is to analyze possible options for processing wood from the timber industry complex of Russia and its waste into secondary products. A fifth of the total felling area is used for deforestation. The breed most used for processing in Russia is larch. In forestry and woodworking, waste can be both whole trees and their individual parts, it depends on the purposes for which the felling is performed. Only 20 % of timber waste is recycled. The rest are disposed of by incineration in loggings or taken to landfills. Wood waste can be used as a raw material for the production of hydrolytic alcohol, rosin, technological chips, the needs of pharmacology, the production of soap and tannins for the tanning industry, in agriculture as fertilizers for heavy soils, bedding for animals, in the thermal power industry – for the production of briquettes and pellets. To assess the possibility of processing wood waste in the Russian Federation, a SWOT-analysis is proposed, which shows strengths and weaknesses, and also identifies risks.
Keywords: wood processing, by-products, timber processing complex, pine needles, sawmill.

INTRODUCTION

Russia is considered one of the largest states in the world with a large-scale timber industry complex [1]. It usually includes harvesting, as well as mechanical and chemical processing of wood. In terms of volume, Russia has 20 % of the world's timber resources [2]. There is a need to improve the processing of waste from the timber processing complex to obtain greater efficiency from enterprises in this industry. Secondary wood resources are promising raw materials for further use and reach 45–50 % of the harvested raw materials [3]. The use of such resources for processing will contribute to the efficient operation of the enterprise. The aim of this work is to briefly describe the possibilities of wood processing to obtain secondary products and the most efficient use of waste from the timber processing complex of the Russian Federation.

TIMBER DISTRIBUTION OF THE RUSSIAN FEDERATION

It is known that in Russia there are about 80.2 billion m^3 of timber [4], and the area of the forest fund of the Russian Federation is more than 1,147 million hectares [5]. In the forests of Russia, there are over 1500 species of trees and shrubs, valuable conifers prevail, accounting for 90 % of all tree species [6]. The structure of forest distribution in the Russian Federation is shown in Fig. 1

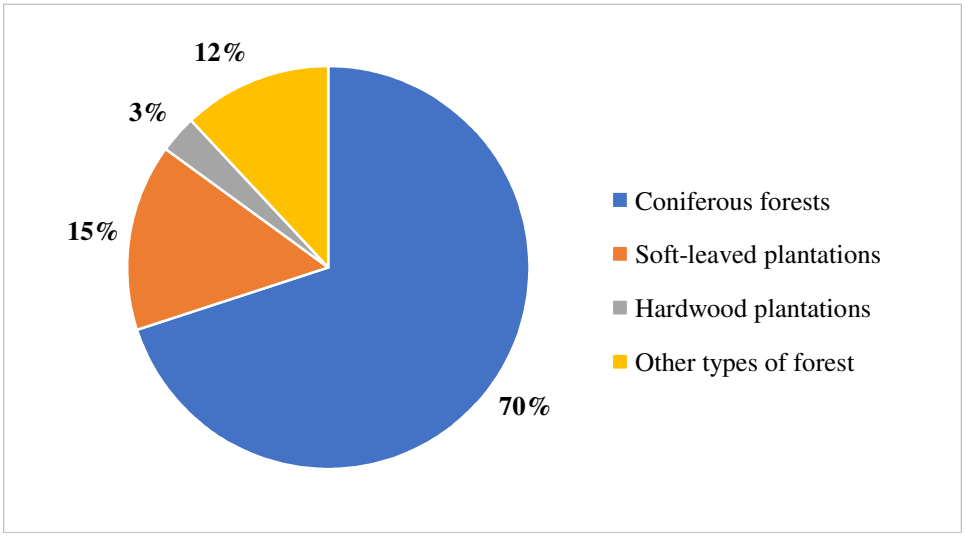

Fig. 1. Diagram of the structure of forest distribution (compiled by the authors).

The increase in the volume of timber harvesting in Russia is about 540 million m^3 per year, and the cutting area determined using a special calculation (the forest area available for felling, without a detrimental effect on the environment) is about 800 million m^3 [7]. Currently, only one-fifth of this value is used [8, 9]. When harvesting wood, first of all, ripe and matured stands are used (ripe species aged from 80 to 100 years, matured – over 100 years). Such types of forests currently occupy more than 65 % of the total forest area, and more than 95 % of them are located in Siberia and the Far East [6]. The largest amount of wood in Russia comes from pine, spruce and larch. The most stable demand is for deciduous and coniferous species (oak, pine). The stocks of coniferous forests in Russia are 1.8 times higher, and the depletion of forests is 2–3 times less than in the USA, Australia, Canada and other wood exporters. Softwood is widely used in the construction and pulp and paper industry. [10].

Hardwoods are widely used as ornamental materials – oak, beech, birch, aspen, linden and others [11, 12].

THE STRUCTURE OF THE RUSSIAN TIMBER PROCESSING COMPLEX

The timber processing is one of the oldest types of production of structural materials and consists of the following interconnected industries that differ from each other in production technology, product purpose, but use the same raw materials [13, 14]:

• logging, felling, transportation (delivery to the consumer);

• mechanical processing – includes sawing, manufacturing and processing of blanks [15].

Machined products include plywood, lumber, furniture, matches, parquet, etc.;

• wood chemistry is the production of cellulose, paper and other products [16];

• an intermediate position is occupied by the pulp and paper industry, where chemical technologies are used in conjunction with mechanical processing and include the production of cellulose, rosin, wood alcohol and fodder yeast [17]. If you look at the map of the timber industry complex in Russia (Fig. 2), then the following branches are identified in the structure of the timber industry system:

• logging, sawmill - the main areas of sawmilling: Northern, Volgo-Vyatka, Central, Volga, Ural, Western and Eastern Siberia;

• furniture production – Central, North-West, Ural, North-Caucasian, Povolzhsky regions;

• typical housing construction – Ural, North, North-West, Volgo-Vyatka, Central and East Siberian regions;

• pulp and paper industry – Northern, Volgo-Vyatka, Ural and East Siberian regions;

• hydrolysis industry – North, North-West, Ural, Volga, East Siberian regions;

• chemical and mechanical processing of wood – Northern, Volgo-Vyatka, Ural and East Siberian regions [18].

Fig. 2. The map of the location of the main timber industry in Russia [18].

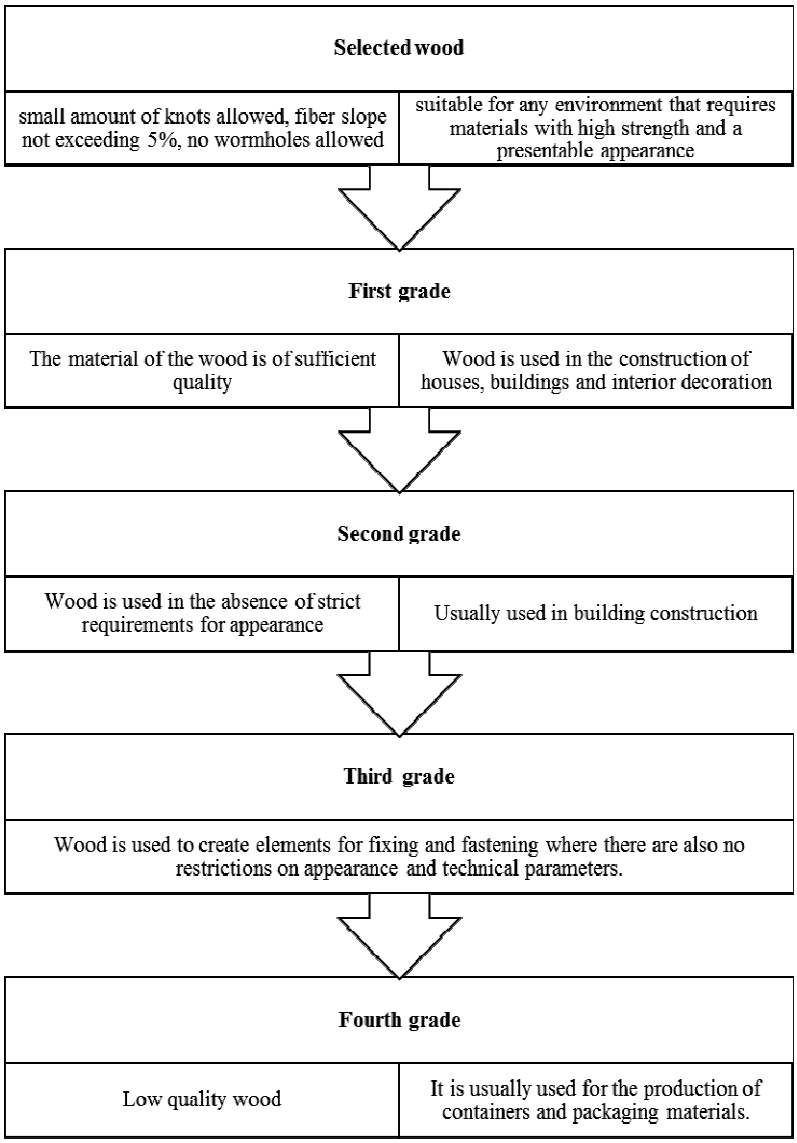

Fig. 3. Wood classes according to construction qualities (compiled by the authors).

The main forest-forming species is larch, which, as a rule, is difficult to process. The qualities of larch – high density, firmness, solidity and resinousness – pose problems for its processing. To ensure the durability of products made from it, it is necessary to use in the production lumber with a moisture content compatible with the operational one. Larch wood is prone to cracking and warping even during air drying, so a radial cut is usually recommended for it. But it is often tangential cutting that is used, in which the wood is strongly warped and cracked not only during drying in convective chamber dryers, but also during simple atmospheric drying. Even full compliance with the requirements for

stacking lumber and placing the stack in a warehouse for long-term storage leads to the formation of deep "spider" and end cracks [19]. The greatest load falls on the European north, the south of Siberia and the Far East. The first place in logging is occupied by the European north (the republics of Komi and Karelia, the Vologda and Arkhangelsk regions) – 20 %. There is an extensive network of rivers, logging roads (Kotlas-Vorkuta, Vologda-Arkhangelsk, Petrozavodsk-Murmansk), a timber export port – Arkhangelsk. The important role of this region was predetermined by the main consumers - the Center and the Volga region. In second place is the East Siberian region (south of the Irkutsk region, Krasnoyarsk Territory). Part of the forest is rafted along the Yenisei to the port of Igarka, and most of it along the Trans-Siberian Railway to the European part [10, 20]. The third place is taken by the Urals (Sverdlovsk and Perm regions) – 18 %. Each wood species has a unique set of characteristics that provide distinctive advantages and disadvantages. In Russia, according to GOST 8486-86 [8], depending on the shortcomings, all coniferous tree species are divided into 5 classes.

TYPES OF WOOD WASTE AND METHODS OF THEIR PROCESSING

If we start from the territorial formation of wood waste, then they distinguish [21]:

• logging (logging sites);

• industrial (wood processing at enterprises). The former includes various branches, bark, twigs, etc., the latter – shavings, sawdust, dust and others. Wood waste can be classified according to the following criteria (Fig. 4):

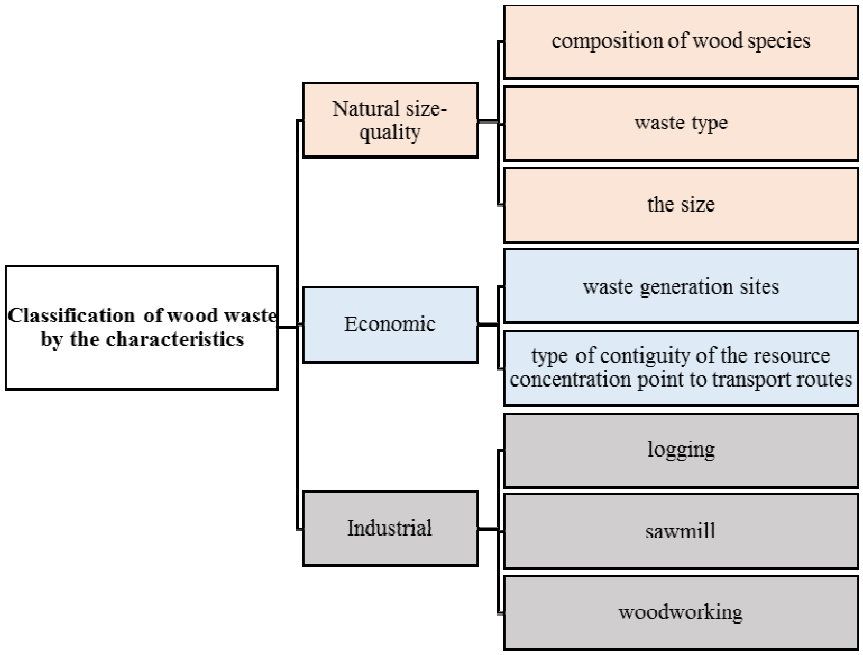

Fig. 4. Classification of wood waste by size, quality, economic and production characteristics.

Any activity related to the extraction or processing of wood is at the same time a supplier of waste, and the type of this waste directly depends on the activities of the enterprise or organization. In forestry, waste can be both whole trees and their individual parts [22], it depends on the purposes for which the felling is performed. Currently, there are several key methods of wood processing [23–25]:

• mechanical (changing the shape of wood mechanically, that is, sawing, carving, splitting, etc.);

• chemical-mechanical (obtaining an intermediate material for further use, for example plywood);

• chemical (use of heat treatment and solvents, the input of which is obtained, for example, charcoal).

A logical consequence is the fact that the most effective direction is the processing, which allows you to get a new product with the maximum use of raw materials.

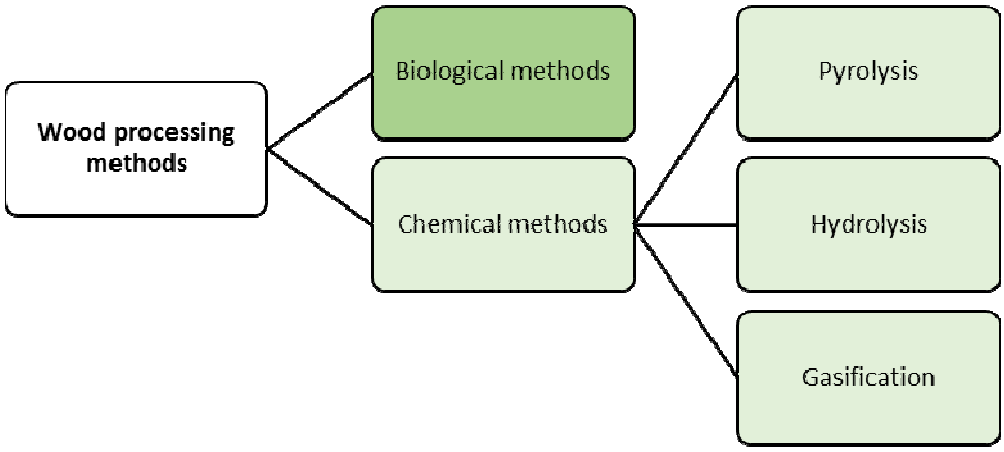

Fig. 5. Modern technological methods of wood processing with the maximum use of raw materials (compiled by the authors).

Of the huge mass of waste, only about 20 % is used, and the rest is disposed of by incineration in clearings, warehouses or thrown into a landfill [26]. Reducing wood losses by only 1 % would increase the security of the national economy in wood raw materials by 1 million m3 and save 7–8 thousand hectares of forest plantations from felling, saving labor, material and monetary resources [27]. A large amount of waste, over 20 % of the total volume of harvesting, is generated at sawmills [28]. Cut and branched trunks, also called whips or logs, are delivered from thinning areas to sawmills, where they are sawn into planks, beams or other sawn timber. The main product at this stage is precisely sawn timber, and the waste is slabs and sawdust. Another consumer of logs is woodworking enterprises producing building materials, as well as various chemical products [29]. In

wood processing enterprises, bark and various pruning are waste products. Finished boards are delivered to construction sites and enterprises, including furniture, where they are processed for further use. At construction sites, the main type of waste is all kinds of trimmings, but processing plants, in addition to trimmings, also produce shavings. Many enterprises recycle waste into shavings, because they are lighter to process or sell [30].

WAYS OF USING WOOD PROCESSING WASTE

Wood waste can be used as a raw material for hydrolysis production, the production of rosin, technological chips and wood pulp, the production of building and furniture boards, in the production of activated carbon and explosives, as raw materials, additives for the needs of pharmaceutical production, as well as the production of soap and perfumery, production of tannins for the tanning industry, pressed fuel blocks, various concretes based on wood fillers [31].

Wood sawdust, shavings, grinding dust are already actively used in agriculture as an additive to fertilizers for heavy soils, in animal husbandry – for the underlying layer [32]. Lignin, as a waste product of cellulose production and hydrolysis of plant raw materials, can be widely used for the needs of ferrous and nonferrous metallurgy as a substitute for coke and charcoal, in ceramic production, in the production of cement, concrete, porous materials. Bricks, refractories can also be created in the production of granular coal. This also includes sorbents, carbon-containing raw materials in various industries [33]. In order to increase the energy and economic efficiency of processing enterprises in the oil and fat industry (reducing the consumption of fuel and energy resources, saving natural raw materials), it is advisable to use biofuel boilers: sunflower husk and fuel briquettes produced from biomass of sunflower, soybean, rapeseed and wood stalks [34]. The most effective areas of waste use are the production of technological chips for the manufacture of wood-based panels from shredded wood and cellulose, as well as the use of illiquid wood and waste as fuel [35].

In the production of fuel briquettes and pellets, the technological process includes a number of operations: crushing of illiquid wood and wood waste (small-sized meter, slab, slats, etc.); sorting of raw materials (wood chips, shavings, veneer); primary grinding of raw materials into particles ranging in size from 0.5 to 50 mm; drying of particles to a technological humidity of 10–12 %; secondary grinding; briquetting (granulation) [36]. Sawdust and bark are now widely used in factories as fuel. Surplus sawdust is sold to companies producing pellets, briquettes, particle boards and MDF boards. One of the stable trends is the creation of pellet production at the sawmills themselves [37]. So, in Russia the production of pellets works at the enterprises Stora Enso (Setlehs and Setnovo), Sawmill 25, Trans-Siberian forest company, Woodworking company "Yenisei", etc. Many enterprises plan to organize the production of pellets or briquettes [38].

SWOT analysis for wood processing processes in a woodworking plant. In order to function successfully in the long term, an organization must know its strengths and weaknesses, be able to predict what difficulties may arise in its path in the future and what new opportunities may open up for it. Table 1.

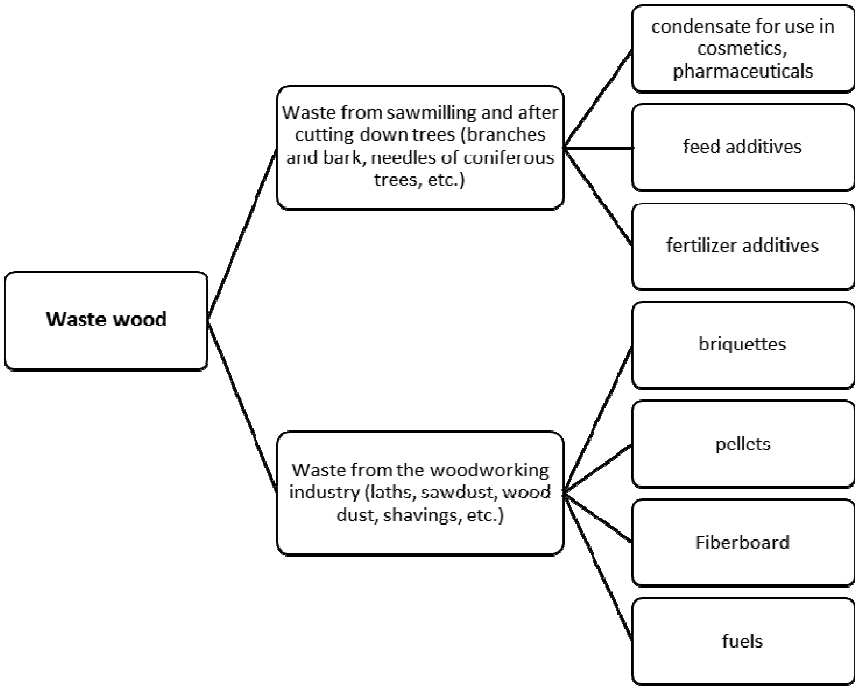

Fig. 6. Use of wood waste (compiled by the authors).

Table 1

SWOT analysis of the possibility of wood waste processing at a timber processing plant [39]

STRENGTHS	**WEAKNESS**
– Availability of qualified personnel – Convenient location of the plant, proximity to highways – Availability of suppliers and consumers – Availability of all communications	– The presence of old equipment – High prices for products – Weak marketing policy – The presence of strong competitors – Lack of government support
OPPORTUNITIES	**THREATS**
– High demand for products from woodworking waste – Application of new technologies for the production of products from waste – Release of quality products – Entering other sales markets – Attracting investors	– Unstable financial situation – Low profitability of the plant – Threat of bankruptcy

CONCLUSIONS

1. In the Russian Federation, one fifth of the total felling area, which is 540 million m^3, is used for deforestation. The total forest growth is about 800 million m^3 per year.
2. The most stable demand is for deciduous (oak, beech, birch, aspen, linden) and coniferous (spruce, pine, larch) tree species. The main forest-forming species in Russia is larch, but it is difficult to process because of the high density, strength, hardness and resinousness of the tree. It also has a high tendency to crack when sawing.
3. Coniferous wood, depending on the shortcomings, is divided into selected, first, second, third and fourth grade. The last – fourth grade is low-quality wood, which is used for the production of containers or packaging materials.
4. In forestry and woodworking, waste can be both whole trees and their separate parts, it depends on the purposes for which the felling is performed. Logging waste is bark, twigs, branches, etc. Industrial waste - shavings, sawdust, dust, etc.
5. Only 20 % of wood processing waste is recycled. The rest are disposed of by incineration in clearings or taken to landfills. Reducing wood losses by only 1.0 % will save 7–8 thousand hectares of forest plantations from felling, as well as save labor, material and financial resources.
6. Wood waste can be used as a raw material for the production of hydrolytic alcohol, rosin, technological chips, the needs of pharmacology, the production of soap and tannins for the leather industry, in agriculture as fertilizers for heavy soils, bedding for animals, in the heat power industry – for production briquettes and pellets.
7. For the successful functioning of a wood processing enterprise, a SWOT analysis is proposed, which identifies the strengths, weaknesses, as well as threats and opportunities for wood waste processing in the Russian Federation.

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Алексеенко А. А. Переработка древесины лесоперерабатывающего комплекса России и ее отходов во вторичные продукты / А. А. Алексеенко, Д. В. Шушпанова // Ученые записки Крымского федерального университета им. В. И. Вернадского. Биология, химия. – 2021. – Т. 7 (73), №2. – С. 3–13.

При обработке древесины образуются сопутствующие отходы, следовательно, существует потребность переработки таких отходов во вторичные продукты с целью их дальнейшего использования. Целью данного исследования является анализ возможных вариантов переработки древесины лесопромышленного комплекса России и ее отходов во вторичные продукты. Для вырубки леса используется пятая часть от общего объема лесосеки. Наиболее используемая для обработки в России порода – лиственница. В лесном хозяйстве и деревообработке отходами могут быть как целые деревья, так и их отдельные части – это зависит от целей, для которых выполняется рубка леса. Перерабатывается только 20 % отходов лесопереработки. Остальные утилизируют сжиганием на вырубках или отвозят на свалки. Древесные отходы могут быть использованы как сырье для производства гидролизного спирта, канифоли, технологической щепы, нужд фармакологии, производства мыла и дубильных веществ для кожевенной промышленности, в сельском хозяйстве в качестве удобрений для тяжелых почв, подстилки для животных, в теплоэнергетике – для производства брикетов и пеллет. Для оценки возможности переработки древесных отходов Российской Федерации также предложен SWOT-анализ, который показывает сильные и слабые стороны переработки, а также выявляет риски функционирования деревообрабатывающего предприятия в долгосрочной перспективе.

Ключевые слова: переработка древесины, побочные продукты производства, лесоперерабатывающий комплекс, вторичные продукты, хвоя, лесопилка.