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TECHNICAL SOLUTION FOR SCUTCHING THE RAW BAST MATERIAL

Introduction. *The research deals with problems of development of scientific framework for resource-saving technologies for complex processing of bast crops.*

Problem Statement. *In recent years, the problem of sustainable development of the country has aggravated. The critical features of production flowchart for processing raw bast material in Ukraine in order to develop adequate scenarios of its development have been identified.*

Purpose. *The purpose of the research is to develop theoretical aspects of obtaining bast fibers with given qualitative indicators.*

Materials and Methods. *The research uses the methods of theoretical generalization and comparison, analysis and synthesis. The search of ways for improving the quality and expanding the assortment of high-quality bast products using different methods of treatment has been discussed.*

Results. *The modern level of domestic and foreign research works on the problems and promising directions of development of primary processing of bast fibers has been generalized. The theoretical aspects of more efficient use of raw flax materials available in the country have been elaborated.*

Conclusions. *Based on the research of anatomical and chemical structure of bast stems and configurations of a group of breaking-and-shaking and scutching-and-cleaning machines for pretreatment of industrial fiber, the need of creating a new device for mechanical treatment of these crops to produce fiber with given qualities has been theoretically substantiated and experimentally proved. New ways for stem destruction based on the compression, fracture, sliding flexure, scraping, inertial forces, friction, pressure, and tension, which contribute to the stem disintegration and increase in fibers separation, have been proposed. These ways are based on the device for separating the woody parts and deflaking. Innovational configuration of scutching unit for processing raw bast materials, which provides raising efficiency of breaking the connections between woody part and fiber of raw bast material and separating the fibers from woody part and other non-fibrous impurities have been developed. This scutching unit has a versatile application for processing the stems of bast crops.*

Keywords: fiber, flax, raw material, quality, cleaning, processing, equipment, and production.

From ancient times flax and hemp were used by man in various spheres of economy. These plants are important crops in ecological and agricultural aspects. They are valuable raw materials for textile, medical, and cosmetic industry. Bast crop products and their properties are widely used in the manufacture of fabrics for ordinary and special purpose clothing, gauze, wadding, other medical goods, including those for defense purposes, products of various technical application, pulp and paper, etc. [1—4].

Fiber is the main valuable component of these plants. Now, worldwide the growing demand for flax and hemp fiber is driven mainly by expanding its unconventional use that is to replace synthetic materials in automotive and aircraft engineering, pulp and paper industry. At the same time, the seeds of these crops are equally impor-

tant for the national economy and used for manufacturing oils, varnishes, cosmetic and medical preparations, zoo-hygiene products, and feed additives [5—7].

One of the reasons for economic, environmental, and social problems in Ukraine has been the recent slowdown in the domestic light industry and enterprises processing the bast crops. The decline and stagnation in some agricultural subsectors took place in the first years of Ukraine's independence, when they failed to take advantage of political and economic opportunities they had obtained, and lost, among others, flax and hemp growing [4, 8, 9].

The statistics of past years show that by 1992, Ukraine was one of the world leaders in the production of flax fiber, with the gross yield exceeding 100 thousand tons annually (13—16% of world output). By that time about 40 thousand ton fibers were processed by domestic enterprises, with the rest exported abroad for more than USD 40 million. Flax and hemp breeding and growing were highly profitable activities for agricultural and processing enterprises. Occupying 7—12% of farm areas, the fiber or long-stalked flax and hemp provided a significant portion of all plant growing income, which enabled to successfully address the economic and social development of rural regions [6, 7, 10].

For Ukrainian agricultural producers of Polissia region, fiber flax and hemp were traditional crops that simultaneously gave three types of products: fiber, seeds, and boon (woody and cortical portion of flax). So far, each component is very important for the national economy. Due to their unique consumer properties, flax and hemp products are in high demand both in Ukraine and abroad [1, 7, 11—13].

Over the past two decades, flax and hemp growing has undergone a major decline as compared with other agriculture sectors. At the same time, Ukraine has lost its leading position in the world production of bast crops. Thus, the area under fiber flax decreased almost 25 times, the gross yield of fibers dropped 28.8 times, and that of seeds fell 23.5 times. In 1990—1992, Ukraine's share in the world production of flax fiber was 15.7%, while in 2007, it was less than 1% [10, 14, 15]. Previously, flax growing was the leading industry in Chernihiv, Zhytomyr, and Volhynian Oblasts, with its profitability reaching 130–140%. Today, it may seem an unrealistically high indicator. The gross flax fiber yield was 15,500 tons or 15% of the harvest in Ukraine. Unfortunately, over the years of independence, in Volhynia, the area under flax decreased from 25.3 thousand hectares to 225 hectares, with the yield dropping twice [7, 10, 16]. Nowadays, the production is associated with the loss of valuable fiber and seeds. Flax and hemp are grown mainly for cattle feed or burn in the fields. Destructive processes in the industry has led not only to the loss of the foreign market of fiber, which is a source of foreign exchange revenues to the national budget, but also to a decline in fiber processing at domestic enterprises with further complete stoppage of domestic flax processing business and linen factories [7, 10, 17, 18].

Agrarians complain that today, added-value processing of domestic raw flax is almost absent in Ukraine, with manufacturers of flax-based finished products counted on fingers of one hand. The main consumers of flax are food (Nizhyn Fat Factory), chemical (*Factoria*), pharmaceutical (*Liktravy*), and light industries (Kharkiv Rope Plant and Kirovohrad Twine-Rope Factory). Unfortunately, the only oil extraction plant in Donetsk, which is specialized in the processing of flax seeds has suspended operation for an indefinite period because of military actions in the region. In addition to the textile manufacture (*Linen Gallery* and *Zhytomyr Flax*), the flax products are used as thermal insulation in construction (*Lintex*) and as sound insulating materials in automotive industry.

The causes of this catastrophic situation in flax and hemp growing are as follows:

1) the unpreparedness of linen and hemp factories to new forms of management related to the need to grow and to process flax and hemp raw

materials by themselves, the lack of modern facilities and logistics, experienced staff, and appropriate flax and hemp processing equipment;

2) collapse of a single interconnected system formed by the linen and hemp complexes of Ukraine, which include several industries, many enterprises, research institutions, laboratories, and other organizations linked by close industrial, technological, and economic relations;

3) the economy transition from rigid planning to market conditions without any structural transformations and state regulation has led to a collapse of industrial, technological, and economic ties between individual industries and linen and hemp factories and to the lack of secondary and added-value processing of raw materials;

4) a narrow application scope of products manufactured from bast crops in Ukraine as compared with world advanced economies.

Ukraine is losing its raw material potential based on growing and processing of flax and hemp that are traditional industrial crops for our country, and, in economic terms, the independence in the manufacture of consumer goods made of natural fibers.

Therefore, the development of flax and hemp growing in Ukraine is important and relevant for the issue on the today's agenda, and the problems associated with equipping the factories for primary processing of bulk raw materials, applying new structural elements, methods, and technologies to provide the manufacture of innovative products that have competitive advantages over counterparts or predecessors should be solved from the standpoint of advanced technology and science, with the use of a special extraordinary approach based on the best practices of bast crops processing.

ANALYSIS OF RESEARCHES AND IDENTIFICATION OF UNSOLVED PROBLEMS

The theory and practice of re-equipment, technological upgrade, and use of high-performance machines for processing bulk raw materials [5—8, 13, 19, 20] give reasons to assert that at the current stage of development of light industry in Ukraine to obtain good results in the processing of flax and hemp stem material, especially the low-demanded one, is impossible unless to apply innovative processing solutions taking into account the anatomy, the physical and mechanical properties of these plants, the existing and future needs of the consumer market, the design features, and advanced high-tech innovations in bast material processing using new machinery.

The theoretical and experimental studies have shown that the use of conventional technology for processing of domestic bast crops based on separation of long and short fibers and existing equipment is inefficient. The analysis of engineering and technological prospects described in [7, 21, 22] has led to conclusion that for obtaining homogeneous fibrous mass it is necessary to use diversified large-dimensioned machinery.

Today, there are discussions on advanced technologies for processing of stem material and scientific framework for designing high-performance machinery, equipment, and components the use of which can effectively improve both qualitative and quantitative characteristics of final products. However, the problems of design and use of modules of scutching and breaking machines have remained partially unsolved despite the fact that innovative solutions can essentially improve separation and purification of bast fibers.

Synthetic and artificial materials dominating in the human environment, the use of natural components becomes a pressing problem insofar as due to their safe, environment friendly, and sometimes, valuable healing properties they can prevent global environment crisis [4, 9]. Therefore, the expansion and effective use of resources with a high content of natural product have come to the fore. Since the bast crops are virtually the one vegetable resource for the light and other industries of European continent, the manufacturers have been showing a growing interest in them. In increasing frequency, the EU countries use biomaterials and components of vegetable origin, including flax and hemp, for needs of construc-

tion, automobile and other industries. To meet these needs European countries are expanding the area under these crops thereby widening opportunities for implementing green initiative in the society through manufacturing semi-finished and finished goods from natural materials [8, 10, 19, 20].

So far, many researchers have studied the problems of manufacture and application of products made of processed bast and fiber materials, however, no universal techniques for obtaining the fibrous material have been found, with the industrial equipment used needing to be upgraded inasmuch as its components are pretty metal- and energy consuming and reduce the performance and efficiency of machinery.

The purpose of this research is to find design solutions for the modules of machine for processing raw bast and fiber, to assess the prospects for their further use, and to improve quantitative and qualitative characteristics of the processed stem material. The promising directions of processing industry, specific features of raw bast and fiber treatment, and ways to raise efficiency of its processing have been outlined in this study.

THE RESEARCH AND JUSTIFICATION OF ITS RESULTS

With a rapid development of technical progress, modern methods for added-value processing of fiber flax and hemp in kotonin enable producing yarn of pure material or its blending with cotton, silk, wool or synthetic fibers using the existing equipment in Ukraine.

At present, there are various technological opportunities for recycling woody waste (boon) to manufacture cellulose, slabs for construction and furniture industry, fuel briquettes, and other products.

Today, the paper industry consumes almost half of all timber in the world. At the same time, according to the USDA, hemp gives 4 times more paper per 1 ha than timber and can be grown in all climatic zones, with the paper made of hemp being storable up to 1500 years [10].

In many countries, there is a trend towards implementing heat saving houses, which, in turn, involves the use of environment friendly insulating materials for the manufacture of which flax and hemp are most suitable. The buildings made of hemp boon are as high-strength as cement ones, but have better insulating properties. Hemp fiber blended with plastic bioproducts is used for effective, durable roof coversheets with a long service life.

In increasing frequency, the EU countries use biomaterials and components of vegetable origin, including flax and hemp, for needs of construction, automobile and other industries. To this end, the European countries have planned to grow more than 400 thousand ha hemp and 120—150 thousand ha fiber flax [10].

The linen and hemp products are used holistically, in an integrated manner, in various directions, with the use of advanced equipment for flax and hemp processing. In the view of Ukraine's eurointegration aspirations it must develop this industry.

Inasmuch as Ukraine's industry is transiting to new alternative fuels, flax and hemp can be widely used as alternative energy source. Hemp stems have as good heat capacity as coal. According to estimates of European researchers, it is possible to produce as much methane and methanol from hemp biomass as it is required for providing 90% world electricity needs and sidelining the use of coal, oil, natural gas and nuclear energy.

According to the results of the last three seasons, the production of linseed flax in Ukraine has shown a positive trend. Thus, the linseed flax acreage in the current season has reached an absolute record of 62.15 thousand ha for the period under review, with the harvested area coming to 62.06 thousand ha. However, in the reporting period, under current economic conditions, the production of fiber flax was not very popular (Fig. 1) [10, 23].

It should be noted that processing linseed flax does not show any seasonal trends. A small export-oriented market sector means that process-

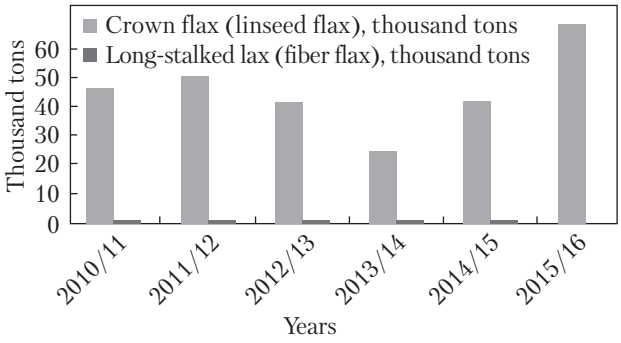

Fig. 1. Gross flax yield in 2010/2016, thousand tons

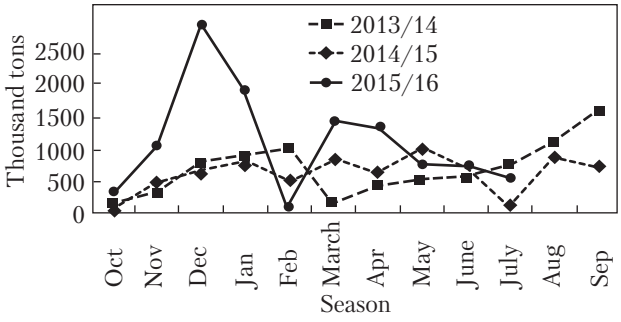

Fig. 2. Seasonal dynamics of linseed processing, thousand tons

ing output depends on supply orders, primarily, the export ones. In 2015—2016, the highest outputs, 2.90 and 1.94 thousand tons, respectively, were reported in December and January [10—12, 23]. Dynamics of linseed processing are given in Fig. 2.

In the three last seasons, flax fiber output showed upward dynamics that correlate with fiber flax acreage. However, the indices have remained poor because of the lack of available raw material as a result of a low popularity of fiber flax among the Ukrainian farmers [24]. Upon results of the reporting period, the flax and linseed imports declined (Fig. 4) drastically and stopped (linseed) or approaches zero (linseed oil). This is explained, among others, by gradually growing domestic harvest of linseed flax and increasing output of its processing.

In the last three years, flax and linseed exports grew by majority of components (see Fig. 5). The largest component showing the highest growth pace is linseed [10—12, 23].

In the reporting period, the share of linseed oil in the export structure increased while that of extraction cake decreased.

The analysis has shown that in the last decade, the linseed flax prevailed over other fibrous plants. Large revenues from export-oriented linseed production stimulated farmers to increase harvested acreage for this crop. In this situation, processing of stem material became a relevant problem, since linseed was exported, whereas the stem part remained unclaimed in the domestic industry. The stems were often abandoned in the fields or burnt out, which led to environment unsustainability.

Linseed flax stem material cannot be treated using the technology for fiber flax processing since these varieties have different anatomical and physical properties and processing behavior. The lack of government interest in the domestic production of fibrous material has led to stagnation in primary processing of bast crops, which entailed almost complete collapse of this industry [7, 21, 24, 25]. Equipment of plants for primary processing of bast crops has outlived its usefulness. Some domestic processing corporations put together parts of several obsolete plants or exported secondhand equipment that gave satisfactory performance from abroad. However, this is not enough for treating raw bast material grown in Ukraine [10, 11, 26, 27].

Under the lack of advanced high-performance processing equipment manufactured in Ukraine and simple affordable processing techniques it is necessary to design modules and equipment for bast and fibrous material processing, which are capable of breaking the stem material with a wide range of properties and possess general functional capabilities to process raw materials.

In terms of treatment of bast fibrous materials scotching and breaking are main processes that play leading role in separation of the fibrous part from the woody and cortical one. They influence both quantitative and qualitative characteristics of obtained fiber. Therefore, the problem of stem material processing must be solved through im-

proving the mentioned processes, searching or upgrading the respective equipment.

Within the framework of research, several improvements for separation of fiber from the stem at the initial stage (feed and breaking) to facilitate the next stages of stem material treatment have been developed [6, 27, 28]. Improvement of scutching process is also required in order to raise effectiveness of stem processing.

Having analyzed data, based on the theoretical and experimental research carried out at the Kherson National Technical University a scutching unit for raw bast material treatment has been designed [29]. The unit is to be used for scutching broken raw bast in order to clean the fiber from woody and cortical impurities. This unit is a part of machine for raw bast treatment.

The device was designed based on specification for improvement of configuration of the scutching unit, in such a way as to ensure effective conditions for breaking the residual ties between the woody part and the fiber, cleaning the fiber from boon and other impurities, widening capabilities for treatment of other types of raw materials, i.e. not only for raising its effectiveness and versatility, but also for improving the operation of scutching machine as a whole due to specific configuration solutions.

The mentioned problem is solved if in the scutching unit that consists of a scutching drum with beater bars above which the scutching knives are located, and meshes placed under the drum, the beater bars have a wavy cross section with their working edge cut at an obtuse angle with respect to the direction of their motion and the profile of each beater bar displaced with respect to the profile of the neighboring beater bars by a half-wave. On the tip of scutching knives, there is a crest-shaped flange. In the center of the scutching unit, above the drum, there are mounted slatted rollers rotatable around the axes. The mesh can move relative to the scutching drum to control the gap between the mesh and the drum.

The scutching unit configuration differs by specific shape of beater bars and scutching knives,

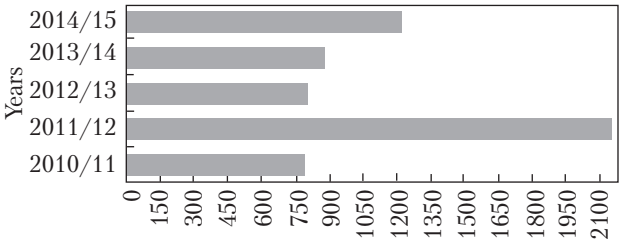

Fig. 3. Flax fiber output, tons

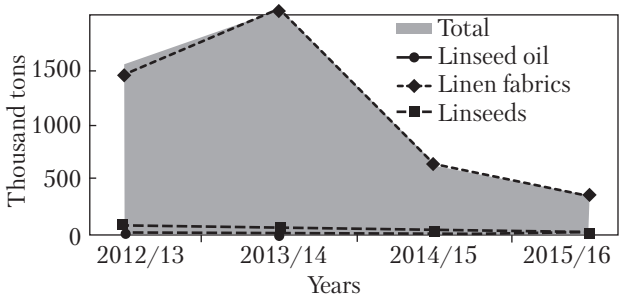

Fig. 4. Linseed and linen products import, USD thousand

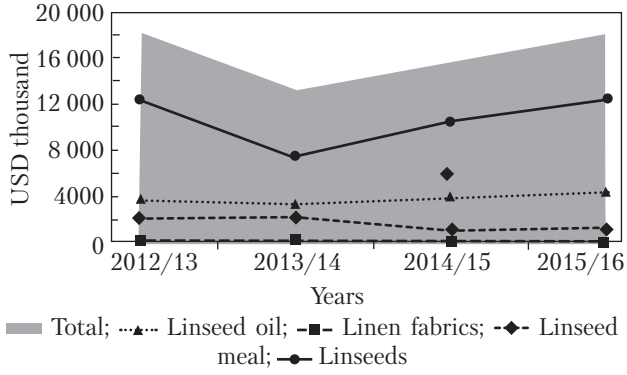

Fig. 5. Linseed and linen products export, USD thousand

their arrangement and interaction as well as by introduction of slatted rollers into the unit.

The use of mentioned configuration of beater bars, scutching knives, their arrangement and interaction enables to raise effectiveness of breaking the residual ties between the woody part and the fiber, separating the fiber from boon and other impurities, which essentially improves the operation and efficiency of the machine.

Fig. 6 features a scheme of scutching unit for raw bast processing. Fig. 7 shows an enlarged projection of beater bar and scutching knife configurations.

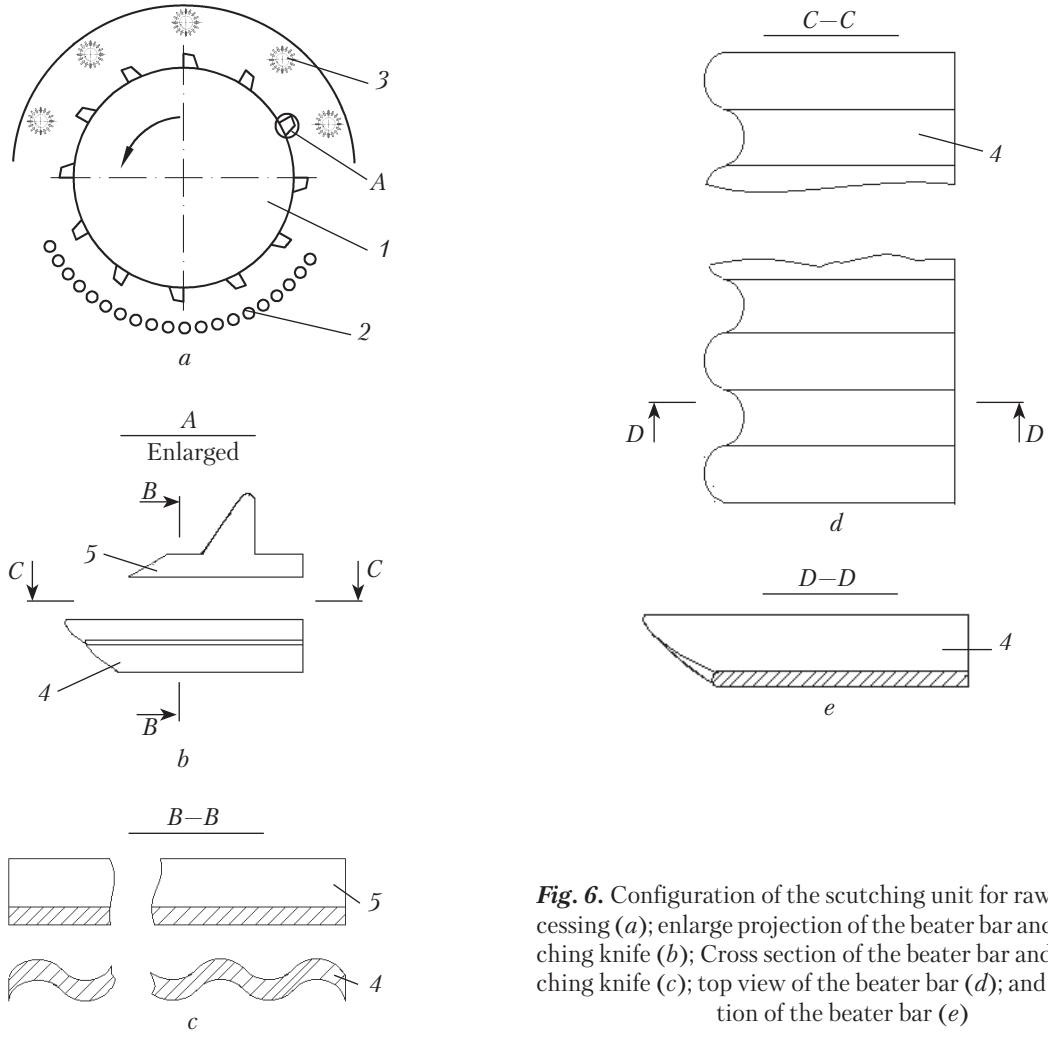

Fig. 6. Configuration of the scutching unit for raw bast processing (*a*); enlarge projection of the beater bar and the scutching knife (*b*); Cross section of the beater bar and the scutching knife (*c*); top view of the beater bar (*d*); and cross section of the beater bar (*e*)

The scutching unit consists of scutching drum *1*, mesh *2* placed under the drum *1*, slatted rollers *3* rotatable around axes and mounted in the center of the scutching unit above the scutching drum *1*. On the scutching drum *1*, there are the beater bars *4* that have a wavy cross section with their working edge cut at an obtuse angle with respect to the direction of their motion. Above them, there are scutching knives *5* having a crest-shaped flange at the top.

The scutching unit operates as follows: a layer of raw bast having been broken in the breaking part of the machine using the pair of feed rollers is fed at an even rate to the scutching unit. The working bodies of scutching drum *1* are beater bars *4* and scutching knives *5*. They are fixed on the motor operated scutching drum *1* and alternately act on the broken raw bast squeezing, bending, and shearing it.

Fig. 8 bears the cross section of beater bar and scutching knife *B-B*. Fig. 9 features a top view of beater bar *C-C*. Its cross section *D-D* is given in Fig. 10.

The use of beater bars *4* that have a wavy cross section with their working edge cut at an obtuse angle with respect to the direction of their motion that have a wavy cross section with their working edge cut at an obtuse angle with respect

to the direction of their motion ensures a proper separation of the boon and other impurities from the fiber. Due to the specific configuration of beater bar *4* cutting edge the bast material slides on the cutting edge and undergoes a bending strain and a shear of woody part relative to the fiber, with the fibers due to their natural flexibility easily enveloping the beater bars *4*, which raises effectiveness of their cleaning. The margin of beater bar *4* cutting edge is radially rounded to prevent any material damage of fibers. The beater bars *4* are located on the scutching drum *1* in such a way that the profile of each bar is displaced relative to the profiles of the neighboring bars by a half-wave. This configuration ensures a larger area of broken raw bast subjected beater bar impact. The scutching knives *5* act on the broken raw bast striping the boon away from the fiber surface. On the surface they have a crest-shaped flange that creates additional inertial and other forces (friction, pressure, tensile load) acting on the broken raw bast. Being subjected to the flange action the bast material slides on the rounded crest tip of the scutching knives *5*, with the bast elements rotating relative to the tip curvature center. The fibers due to its natural flexibility easily envelop the scutching knife tip, whereas the boon does not bend and are separated from the bast layer, which facilitates the boon separation from the fiber with its further removal by inertial forces. Under the action of beater bars *4* and scutching knives *5* as the direction of relative velocity varies so does the absolute velocity of layer elements. As the absolute velocity varies, at the moment of interaction between the layer elements and the working bodies of the scutching drum *1* the elements in the interaction area largely accelerate. The inertial forces caused by this acceleration reach a certain high value and vary proportionally to squared velocity of drum working bodies. These inertial forces and other forces (friction, pressure, tensile load) that appear in the layer while scutching ensure removal of boon and other non-fibrous impurities from the processed material.

Due to the action of beater bars *4* and scutching knives *5* of the drum *1,* under the action of centrifugal forces a part of bast material shifts towards slatted rollers *3* placed in the center of scutching unit, above the scutching drum *1*. The bast material hits the rollers thereby driving the boon out of the bast material layer. The slatted rollers *3* are not fixed and can rotate around the axis.

The boon and other impurities separated from the fibers pour through the mesh *2* placed under the scutching drum *1*. Having been scotched the fiber is fed to the shaker.

Due to the fact that the mesh *2* can move relative to the scutching drum *1,* the gap between the mesh *2* and the drum *1* is adjustable. As the gap decreases, the separation grade betters due to an increase in the bend angle of raw material on the slats of mesh *2* and an increase in friction, pressure, and tensile load. And vice versa, as the gap increases, the separation grade goes down. The adjustable gap between the mesh *2* and scutching drum *1* enables to control the intensity of bast material treatment depending on its initial condition.

As distance between the feed part and the scutching area decreases, the quality of purification improves. The bast material layer is treated by the beater bars *4* and scutching knives *5* of the drum *1* if it is kept in the feed node.

The gaps between the beater bars *4* and scutching knives *5* of the drum *1* are adjusted depending on the type of bast material, its condition and quality.

Varying the rotation speed enables obtaining fibers with various content of boon. The configuration of beater bars *4* and scutching knives *5* makes it possible to treat bast materials with different processability. The maximum rotating frequency of scutching drum *1* allowable for this configuration can be used for processing unripe bast material and material with a high moisture content.

Depending on the type, physical, and mechanical properties of bast material one or several scutching units can be installed in the scutching machine in order to effectively clean the bast from boon and cortical impurities.

The given configuration of the scutching unit enables improving versatility of equipment for bast crop stem processing and can treat all types of domestic raw bast materials.

The use of scutching unit configured as mentioned above makes it possible to raise effectiveness of breaking the residual ties between the woody part and fibers of broken bast and separating the fibers from the boon and other impurities, which enhances the efficiency of the whole machine for bast treatment. The proposed technical solution facilitates removing the boon and other impurities both while scutching and in the next process operations, which increases the fiber quality and output. It has been successfully implemented at Staryi Sambir linen factory.

Hence, the improved configuration of scutching unit components enables not only to raise effectiveness of fiber purification, but also to expand capabilities for processing of domestic bast materials, i.e. to improve versatility and efficiency of their treatment. The obtained fibers are suitable for added-value processing of bast crops, enable to widen the range of goods made of them, to us them in various industries, to stimulate farmers for flax and hemp growing and their primary processing, which, in its turn, enhances their role as leading industrial crops. At the same time, this will lead to a relief in social tension in the rural regions and to a reducing dependence on cotton and wool import, irrespective of foreign exchange allocations to this sector. The proposed technical solutions can facilitate upgrading the flax and hemp industry, developing the light industry and ecomarket of Ukraine, and increasing the employment and involvement of highly qualified experts in the mentioned economic sector.

CONCLUSIONS

Only innovative solutions can better the situation and enhance the competitive ability of linen and hemp products through improving their quality and reducing the manufacturing costs. Implementation of new technologies for flax and hemp processing makes it possible to obtain products possessing new functional properties and thereby to expand the scope of their application and to raise economic attractiveness of the industry.

The world trends have shown that the flax and hemp industry is attractive for investors. Its fate depends primarily on government policy, interest of investors, and comprehensive approach to its development.

The proposed configuration of the scutching unit enables industrial processing of various domestic bast materials and enhances versatility of process scheme. This innovative solution raises effectiveness of raw bast purification due to improved conditions for breaking residual ties between the woody part and the fibers of broken bast and for cleaning the fibers from the boon and other impurities. The use of mentioned scutching unit on industrial scale will not only favorably influence the fiber quality and the quantity, but also stimulate a wider employment of labor resources in poorly developed regions and facilitate social and economic growth in the domestic light industry. Hence, it is possible to enhance the competitive ability of Ukrainian-made products and to speed up the economic growth provided the implementation of this kind of innovative solutions is supported at the government level.

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ТЕХНІЧНІ РІШЕННЯ ПРОЦЕСУ ТІПАННЯ ЛУБ'ЯНОЇ СИРОВИНИ

Вступ. Статтю присвячено вирішенню проблем розвитку наукових основ ресурсозберігаючих технологій комплексної переробки луб'яних культур.

Постановка задачі. В останні роки дуже загострилася проблема екологічно збалансованого розвитку країни. Визначено кризові риси структурної виробничої схеми переробки луб'яної сировини в Україні з метою вироблення адекватних сценаріїв її розвитку.

Мета. Розробка теоретичних аспектів отримання луб'яного волокна з заданими якісними показниками.

Матеріали й методи. У процесі дослідження використано методи теоретичного узагальнення і порівняння, аналізу й синтезу. Розглянуто питання пошуку шляхів підвищення якості та розширення асортименту високоякісної луб'яної продукції різних способів оброблення.

Результати. Узагальнено сучасний рівень вітчизняних і зарубіжних наукових робіт, присвячених проблемам і перспективним напрямам розвитку первинної обробки луб'яних волокон. Опрацьовано теоретичні питання більш ефективного використання наявної в країні лляної сировини.

Висновки. На основі проведених досліджень анатомічної та хімічної будови луб'яних стебел, конструкцій групи м'яльно-трясильних, тіпально-очисних машин для попередньої обробки технічного волокна теоретично обґрунтовано й експериментально доведено необхідність створення нового пристрою механічної переробки цих культур для отримання волокна з заданими якісними показниками.

На основі розробленого механізму відокремлення костри й розволокнення пучків технічних луб'яних волокон запропоновано нові способи руйнування стебла, що базуються на процесах стиснення, зламу, ковзного згину, скобління, інерційних сил, тертя, тиску й натягу, які сприяють руйнуванню цілісності стебла та підвищенню ступеня його розволокнення.

Висновки. Розроблено інноваційну конструкцію тіпального вузла для обробки луб'яної сировини, що забезпечує підвищення ефективності порушення зв'язків між деревиною й волокном луб'яної сировини, відділення волокна від костриці та інших неволокнистих домішок, універсальність використання тіпального вузла для переробки стебел луб'яних культур.

Ключові слова: волокно, льон, сировина, якість, очищення, переробка, обладнання, виробництво.

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ТЕХНИЧЕСКИЕ РЕШЕНИЯ ПРОЦЕССА ТРЕПАНИЯ ЛУБЯНОГО СЫРЬЯ

Введение. Статья посвящена решению проблем развития научных основ ресурсосберегающих технологий комплексной переработки лубяных культур.

Постановка задачи. В последние годы очень обострилась проблема экологически сбалансированного развития страны. Определены кризисные особенности существующей структурной производственной схемы переработки лубяного сырья в Украине с целью выработки адекватных сценариев ее развития.

Цель. Разработка теоретических аспектов получения лубяного волокна с заданными качественными показателями.

Материалы и методы. В процессе исследования использованы методы теоретического обобщения и сравнения, анализа и синтеза. Рассмотрены вопросы поиска путей повышения качества и расширения ассортимента высококачественной лубяной продукции различных способов обработки.

Обобщен современный уровень отечественных и зарубежных научных работ, посвященных проблемам и перспективным направлениям развития первичной обработки лубяных волокон. Обработаны теоретические вопросы более эффективного использования имеющегося в стране льняного сырья.

Результаты. На основании проведенных исследований анатомического и химического строения лубяных стеблей, конструкций группы мяльно-трясильных, трепально-очистительных машин для предварительной обработки

технического волокна теоретически обоснована и экспериментально доказана необходимость создания нового устройства механической переработки этих культур для получения волокна с заданными качественными показателями.

На основании разработанного механизма выделения костры и разволокнения пучков технических лубяных волокон предложены новые способы разрушения стебля, основанные на процессах сжатия, излома, скользящего изгиба, скобления, инерционных сил, трения, давления и натяжения, которые способствуют разрушению целостности стебля и повышению степени его разволокнения.

Выводы. Разработана инновационная конструкция трепального узла для обработки лубяного сырья, обеспечивающего повышение эффективности нарушение связей между древесиной и волокном лубяного сырья, отделение волокна от костры и других неволокнистых примесей, универсальность использования трепального узла для переработки стеблей лубяных культур.

Ключевые слова: волокно, лен, сырье, качество, очистка, переработка, оборудование, производство.