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Secondary Fibrous Materials from Cardboard and Paper Production and Consumption Waste

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Abstract—Some information characterizing wastepaper, including utilization rates, technical data of different fiber grades, and waste paper processing technologies, is presented in the article. Wastepaper obtained from different sources such as cardboard and paper production, production of various goods (e.g. printing companies), and cardboard and paper consumption (e.g. household waste) is also described.

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Wastepaper as a Fibrous Raw Material

The term "wastepaper" refers to waste from production, processing, and consumption of all types of cardboard and paper that can be used as a fibrous raw material. Other names that are widely used alongside with "wastepaper" are "secondary materials" and "secon-dary fiber."

The quantity of generated wastepaper and, consequently, the rates of wastepaper collection and utilization directly depend on cardboard and paper production volumes. Wastepaper was first used as a raw material for cardboard and paper production in the United States at the beginning of XX when the cardboard and paper production rates reached 34 kg/year per capita. Later, wastepaper processing started in European countries as well [1]. In Russia wastepaper was first utilized also at the beginning of XX. In large cities there were small companies purchasing paper waste from the population and enterprises, sorting it out, and supplying it to paper mills. It is possible to judge about the wastepaper processing rates at that time on the basis of the fact that even in the middle of XX (1955) only as little as 250 000 t of this secondary raw material was supplied.

The largest Russian enterprises processing more than 100,000 t of wastepaper per year are St. Petersburg Cardboard and Printing Plant and Naberezhnye Chelny Cardboard and Paper Mill. There is a number of companies processing from 20 000 to 100 000 t of wastepaper per year, including Aleksinskaya Paper and Cardboard Factory (Tula oblast), Sukhonskii Pulp and Paper Mill, Kartontara JSC (city of Maikop), Permskii Karton LLC, SCA mills in the towns of Svetogorsk (Leningrad oblast) and Sovetsk (Tula oblast) etc. There is a great number of small enterprises processing less than 20 000 t of wastepaper per year.

A basic variety of products manufactured using wastepaper is given in Fig. 1 [2]. As can be seen from the provided data, the variety of products manufactured by Russian enterprises on the basis of wastepaper is extremely limited. In the long term the highest growth in wastepaper utilization is expected in production of newsprint paper, corrugated board components, and household and sanitary paper types; in these sectors a large number of new production facilities will use wastepaper as raw materials.

The major advantages promoting increasing utilization of wastepaper as a raw material are described below.

Substitution of 1 t of primary vegetable fiber for wastepaper saves 3–4 m^3 of wood, which makes it possible to reduce deforestation and eliminate logging, transportation, and reforestation costs. The average price for 1 t of wastepaper is 2–4 times lower than the price for 1 t of pulp. As costs for raw materials account for up to 40% of production costs, the use of wastepaper makes it possible to significantly reduce this indicator. Enterprises processing wastepaper spend less energy resources (heat, electricity, and water) and use less chemical reagents to manufacture 1 t of

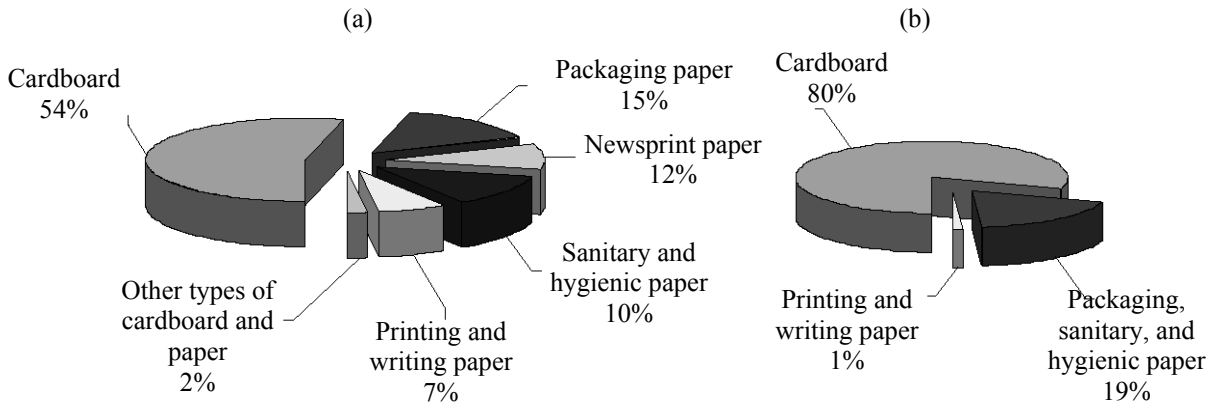

Fig. 1. Variety of products manufactured using wastepaper (a) in the world and (b) in Russia.

products. Wastewater and emission volumes are also significantly reduced. The production profitability increases. Capital expenditures for construction of wastepaper processing enterprises are 2–4 times lower than costs for establishment of wood processing enterprises. Enterprises using wastepaper as a raw material are located in industrially developed regions where major wastepaper resources are formed. Moreover, these districts are characterized by a well-developed infrastructure and qualified personnel; the majority of consumers of cardboard and paper products are also located in these regions. Thus, transportation costs for the supply of raw materials and the delivery of products as well as personnel training expenses are reduced.

Utilization of wastepaper separated from solid household waste leads to decreased volumes of waste in urban landfills. Landfills often suffer from self-ignition and emit harmful components, polluting the air, soil, and water. Therefore, utilization of wastepaper separated from solid household waste is not only economically attractive but also environmentally sound.

No expensive or sophisticated equipment (such as equipment for wood-preparation, cooking, bleaching etc.) is required for wastepaper processing. However, there is a number of problems and bottlenecks related to wastepaper utilization that should be taken into account. As a rule, the quality of products manufactured from wastepaper materials is lower than the quality of products manufactured from primary fiber. It is possible to improve the qualitative characteristics of the products; however, additional investments are required for the purpose. In case of multiple use of a wastepaper material, there is a gradual reduction in its quality. Wastepaper processing also causes the formation of large volumes of pollutants.

A gradual growth in production volumes of water-resistant, impregnated, and laminated cardboard and paper products, an increasing number of auxiliary chemical agents and fillers, and new types of printing complicate wastepaper processing and impose additional costs.

Moreover, there is a number of factors complicating wastepaper utilization that are specifically characteristic of the Russian paper industry. Some of them are mentioned below. The park of the basic equipment is obsolete and worn-out. Outdated (more than 30 years old) paper-making machines account for more than ~75%. There is no serious motivation to create systems for wastepaper collection and sorting by grades. Almost no wastepaper is separated from solid household waste. Systems for the refinement of wastepaper stock (discoloration, bleaching, etc.) are rarely used. Water-resistant wastepaper is not used as a raw material. For a great number of small enterprises (with production capacity below 20 000 t/year) utilizing wastepaper high production costs have a negative impact on the competitive ability of the resulting product.

Wastepaper Processing Potential

The quality of wastepaper is determined by the fact that it is a secondary material that has already gone through a complete cycle (or several cycles) of reprocessing into cardboard and paper products. As a result, the paper-forming properties of the secondary fibers are deteriorated. First of all, the deterioration manifests

itself in shortening of the fibers and a reduction in their swelling ability (water-holding capacity). A partial loss of elasticity and plasticity of the fibers as well as their hardening (hornification) is also possible.

Wastepaper processing potential, i.e. the degree of preservation of the paper-forming properties and the possibility of their restoration, largely depends on the number of wastepaper processing cycles; an increase in this number have a negative impact on the properties of the products manufactured from secondary materials. There is a decrease in the majority of strength properties of the products (stretching property, breaking length, bursting strength, folding strength etc.), while indicators of tearing strength, hardness, and opacity increase. The degree of fineness of the wastepaper stock gradually decreases with a rising number of wastepaper processing cycles (unless the wastepaper stock undergoes additional beating). The paper-forming properties go down as early as after the first two–three wastepaper processing cycles. With further processing the dynamics of the properties decline slows down.

The influence of recycling on wastepaper containing ground-wood fibers is much less than in case of pulp fibers. Under equal conditions bleached pulp is characterized by a greater decrease in the processing potential than unbleached pulp. Introduction of new (primary) semi-finished materials into the wastepaper stock in case of wastepaper reprocessing makes it possible to fully preserve and in some cases even improve the key quality indicators of the produced cardboard and paper.

Modern paper producers make extensive use of chemical additives: sizing agents, fillers etc. Sized fibers retain the hydrophobic properties of their surface to some extent. In case of reutilization of sized fibers their swelling ability goes down and, consequently, their paper-forming properties are partially lost. The type of paper-sizing is extremely important. Thus, paper-sizing using a rosin size in the presence of alums or aluminum sulfates reduces the wastepaper processing potential to a greater extent than paper-sizing in neutral medium. pH of the medium is of major importance for paper formation. According to research works, paper manufactured in acidic medium is characterized by a significantly lower swelling degree than similar paper manufactured in alkaline medium.

A large number of fillers contained in cardboard and paper also reduce the wastepaper processing potential.

Wastepaper stock consists of previously beaten fibers. The higher is the original degree of fineness, the lower is the quality of products manufactured from the wastepaper stock. A high degree of fineness leads to a reduction in the potential of unrealized paper-forming properties of fibers that could be implemented during reprocessing of the fibers.

The greatest impact on the wastepaper processing potential is made by repeated processes of paper drying at the paper-making machine. The reasons for that are an increase in crystallinity and a decrease in the degree of polymerization of pulp fibers at elevated temperatures. The surface of the fibers acquire more hydrophobic properties, there is a decrease in the swelling ability of the fibers and the bonding strength between them. It is this phenomenon which is called irreversible hornification of fibers.

The influence of paper calendering on a reduction in the wastepaper processing potential is the more, the higher is the pressure between the calender rolls. This fact is related to mechanical damage of the fibers at high pressures. However, the higher is the degree of fineness of the paper stock, the less is the influence of calendering.

To a certain extent the wastepaper processing potential is also influenced by the storage conditions and period, which is related to paper ageing processes.

Qualitative Characteristics of Wastepaper Contaminants

Qualitative assessment of wastepaper contaminants is necessary in order to choose an adequate method for their removal during pre-processing preparation of wastepaper stock.

Wastepaper contaminants include substances and particles of non-fibrous origin as well as inclusions of plant origin unsuitable for cardboard and paper production.

Accumulation of contaminants in wastepaper is associated with the cardboard and paper life cycle, including manufacturing, processing, and utilization of cardboard and paper, as well as their further transfer into the category of wastepaper.

When cardboard and paper are processed into various goods, different waterproofing compounds and picture prints are applied to their surface. Moreover, in some cases impregnation (e.g. paraffin impregnation) of paper is carried out. In order to give specific properties

to certain types of products they are coated with laminating substances (polyethylene coatings, latex coatings, foil coatings etc.). All these auxiliary substances and compounds later become wastepaper contaminants greatly complicating processing of the material.

During utilization cardboard and paper products are contaminated with printing components, remains of goods packed in cardboard and paper products, and remains of additional packaging materials (Scotch tape, polystyrene foam, paper clips, strapping etc.). Moreover, during collection and transportation of used cardboard and paper other types of waste can also get into the stock. During storage wastepaper decay is possible; wastepaper ignition results in formation of burnt paper.

The presence of contaminants in wastepaper results in a reduction in the quality of products manufactured using this material and deterioration in their appearance. Mineral inclusions cause abrasive wear and breakdowns of the sorting equipment screens and grinding machine fittings.

Removal of contaminants is one of the main tasks of wastepaper processing technologies.

The quantity of contaminants in wastepaper depends, first of all, on its source of origin. Thus, waste from cardboard and paper manufacturing and processing mostly contains process contaminants, the quantity and range of which are determined by composition of the corresponding products. In turn, waste from consumption and utilization of cardboard and paper products contains unpredictable quantities of contaminants, the qualitative composition of which can also vary. The light fraction, separated from solid household waste via aeroseparation, contains not more than 87% of wastepaper.

It should be noted that volumes of films and plastic materials in solid household waste are constantly rising and, correspondingly, there is an increase in their content in wastepaper. Contaminants in the form of printing inks and fillers are not usually taken into consideration. The weight of printing inks applied to cardboard and paper products ranges from 0.5 to 2.0% of wastepaper weight, while the average weight fraction of fillers in the paper composition varies from 15 to 25%, reaching and even exceeding 30–40% if coatings are taken into account.

Due to a great variety of contaminants in wastepaper it is impossible to give a qualitative description of the contaminants based on one or two parameters. It is only possible to classify them on the basis of individual characteristics. However, it should be taken into consideration that each type of contaminants is simultaneously described by a group of qualitative characteristics.

Below we list a number of qualitative characteristics of wastepaper contaminants that can form the basis for corresponding classifications.

Depending on the degree of connectedness to technological processes of cardboard and paper manufacturing and processing the following types of contaminants are distinguished: contaminants connected to manufacturing and processing, e.g. sizing agents, fillers, dyes, waterproofing compounds, process chemicals etc.; contaminants unrelated to cardboard and paper manufacturing and processing, e.g. metal, sand, plastic, glass, rag, rope, wood etc.; and fibrous contaminants, e.g. lumps, nodules, and bundles of fibers, undissolved fragments of water-resistant wastepaper etc.

Based on the contaminating substance density the following types of contaminants are distinguished: light contaminants (density is less than 1 g/cm^3) including foam plastic, polystyrene, wood fragments etc.; heavy contaminants (density is more than 1 g/cm^3) including metal, sand, glass etc.; and medium-density contaminants (density is close or equal to 1 g/cm^3) including wax, paraffin, latex etc.

Contaminants belonging to the first two groups can be removed from wastepaper stock.

Depending on the size of contaminating particles the following types of contaminants are distinguished: small-size contaminants, the particles of which are smaller than particles of the wastepaper fiber, including particles of paper-making size, inks, and ash within the visual range and beyond (40 μm); large-size contaminants, the particles of which are significantly bigger than particles of the wastepaper fiber, including coarse sand, plastic, textiles, metal, glass, undestroyed film etc.; and contaminants, the particles of which are comparable to the size of wastepaper fiber particles, including large particles of paper-making size, dyes, plastic etc.

Based on the configuration of contaminating particles they can be volumetric (spherical, cubical etc.), flat (leafed, plate-like), or elongated (fiber-like). This classification is quite conventional as many

contaminating particles possess certain elasticity, plasticity, and flexibility (particles of wax, polyethylene, polystyrene, latex, glue, resin etc.) and can change configuration in case of separation.

Depending on the level of wetting ability contaminants can be hydrophobic, hydrophilic, or neutral. The differences in the degree of wetting ability are taken into account when methods for removal of the contaminants from the wastepaper stock are chosen.

Based on their behavior in high-temperature sections of the paper-making machine the contaminants can be either adhesive (adhering to rolls and cylinders, creating tearing danger), e.g. wax, polyethylene, paraffin, latex, glue etc., or neutral (not adhering to rolls and cylinders), e.g. sand, fillers, polystyrene etc.

This list can be continued. Possible combinations of parameters of individual contaminants make the full range of wastepaper contaminants almost unlimited.

The method for removal of specific types of contaminants is determined on the basis of the most distinguishable property of their particles.

In Russia there is GOST 10700-97 State Standard for Paper and Cardboard Waste regulating operations with wastepaper [3]. An attachment to the State Standard contains a list of contaminants disallowed in the composition of wastepaper. Such contaminants include: (1) contaminants on the paper (cardboard) basis: parchment and parchment paper, tracing paper, metalized paper and cardboard, paper and cardboard coated with lacquers, dyes, synthetic materials, synthetic resins, and fat, water-resistant paper and cardboard types etc.; (2) chemical and other contaminants: printing inks, metal fasteners (e.g. folder locks, wire pieces, paper clips etc.), construction materials (cement, gypsum, gravel etc.), minerals and chemical products (fertilizers, detergents etc.), remains of food and feeding stuffs, sand, dust, mud, soil, tobacco etc.

Wastepaper Groups and Grades

As practice shows, in order to achieve the required quality of specific products manufactured from secondary fiber only certain types of wastepaper should be used. Violation of this principle results in lower production quality or higher costs of wastepaper preparation. In this connection all wastepaper types are divided into groups and grades. The major characteristics of this division are as follows: wastepaper origin (waste from production, processing, or utilization); degree of wastepaper contamination with foreign materials (white, slightly contaminated, heavily contaminated, colored, printed, with coatings, impregnated etc.); uniformity of wastepaper composition (mixed, sorted); content of ground-wood fibers in wastepaper (containing no ground-wood fibers, containing a limited quantity of ground-wood fibers, or containing only ground-wood fibers); content of sulfate unbleached pulp in wastepaper (containing no sulfate unbleached pulp, containing a limited quantity of sulfate unbleached pulp, or containing only sulfate unbleached pulp); and wet strength of wastepaper stock (water-resistant, not water-resistant, and products with water-resistant coatings).

Other characteristics for division of wastepaper into groups and grades are also possible. There is a tendency towards an increase in the number of characteristics for wastepaper division related to the growing rates of application of wastepaper materials.

As a rule, the number of grades of recycled wastepaper materials is directly connected to the volume and quantity of major types of cardboard and paper products manufactured and recovered on the territory of the country. Thus, in Poland wastepaper is divided into 4 grades; in Czech Republic – into 7 grades, in England – into 11 grades, in Russia – into 13 grades, in Finland – into 20 grades, and in Germany – into 41 grades. In 2001 countries of the European Union accepted EN643 European Standard, according to which all wastepaper grades are divided into 5 groups. The overall number of grades is 57.

In Russia according to GOST 10700-97 State Standard for Paper and Cardboard Waste wastepaper is divided into 3 groups: group A – high quality wastepaper; group B – medium quality wastepaper; and group C – low quality wastepaper.

Group A consists of the following 4 grades: MS-A – waste from white paper production except for newsprint paper (printing paper, offset paper, writing paper, drafting paper, drawing paper etc.); MS-2A – waste from production of all types of white paper in the form of paper scraps with ruling and black-and-white or color stripes (printing paper, offset paper, writing paper, chart paper, drawing paper etc.); MS-3A – waste from paper production using sulfate unbleached pulp (bag paper, wrapping paper, paper twine, and electrical insulating paper); and MS-4A – used paper bags, not water-resistant (without impregnation,

interlining, or reinforcement of layers). Apart from MS-4A, this group of wastepaper also includes production waste (not printed, not colored). MS-3A and MS-4A grades contain fibers of sulfate unbleached pulp characterized by the highest processing potential.

Group B consists of the following 3 grades: MS-5B – waste from production and consumption of corrugated cardboard and its components (cardboard for liners and paper for corrugation); MS-6B – waste from production and consumption of all cardboard types (except for electrical insulating board, roofing board, and shoe board) with black-and-white and color printing; and MS-7B – used books, magazines, brochures, booklets, catalogues, writing-pads, notebooks, posters, and other types of printing products and paper-stationery products with monochrome and color printing, without bindings, covers, or book-backs, printed on white paper. Apart from production waste, this group of wastepaper also includes cardboard consumption waste and paper products on the basis of white paper.

Group C consists of the following 6 grades: MS-8C – waste from production and consumption of newspapers and newsprint paper; MS-9C – paper cartridges, paper tubes (without cores or plugs), and paper spools (with no coating or impregnation); MS-10C – molded paper articles; MS-11C – waste from production and consumption of cardboard and paper with impregnation and coating (water-resistant, bituminous, or laminated); MS-12C – waste from production and consumption of black or brown cardboard and paper, copy paper, paper coated with dispersed dyes, and roofing board; and MS-13C – waste from production and consumption of various types of cardboard, white and colored paper, including articles that do not belong to other wastepaper grades (with the exception of MS-11C items). The specific feature of this wastepaper group is a wide range of cardboard and paper products it embraces, including water-resistant materials and articles containing ground-wood.

The presented classification of wastepaper types is based on the same principles as the European system; however, it is not sufficiently differentiated and needs further elaboration in this respect.

Preparation of Wastepaper Stock

Wastepaper preparation involves processing of wastepaper into a fibrous material to be used for cardboard and paper production instead of primary semi-finished materials (pulp, ground-wood etc.) without falling outside the acceptable quality limits for the end product. Wastepaper preparation ensures optimal restoration of the paper-forming properties of wastepaper fiber; optimal removal of undesirable foreign inclusions; and optimal restoration of purity (refinement) of the wastepaper stock. Purity of the wastepaper stock is characterized by its optical, chemical, colloidal, microbiological, and other processing properties.

During designing and selection of the process flow scheme for wastepaper stock preparation the following factors are taken into account: the requirements to the end product; the type of wastepaper to be processed; the desired degree of technological flexibility (possibilities for adjustments and readjustments); the enterprise's readiness for capital and operational costs, and the acceptable level of financial risk.

The whole technological procedure of wastepaper processing can be divided into 4 stages. The first two stages involve mechanical processing of wastepaper. The other two stages involve the use of chemical agents to implement certain physicochemical processes.

The first processing stage includes dissolution, rough preliminary cleaning and/or sorting, and additional deflaking of the wastepaper stock. During this stage the paper-forming properties of the secondary fibers are partially restored and the resulting semi-finished product can be used in the composition of cardboard for corrugated board liners (without printing) and for corrugating paper (fluting).

The second processing stage includes rough and fine cleaning, sorting, fractionation, thermal-dispersion treatment, and/or beating of the wastepaper stock obtained as a result of the first processing stage. During this stage the paper-forming properties of the fibers are formed and developed. The obtained material can be used in manufacturing of corrugated cardboard with printing. If high quality wastepaper (MS-1A, MS-2A) is used as a starting material, after the first two processing stages it is possible to obtain a fibrous semi-finished product that can be used in the composition of sanitary and hygienic paper, exercise-book paper, wallpaper, and other paper types.

The third processing stage involves refinement of the wastepaper stock, i.e. removal of printing inks through flotation or washing.

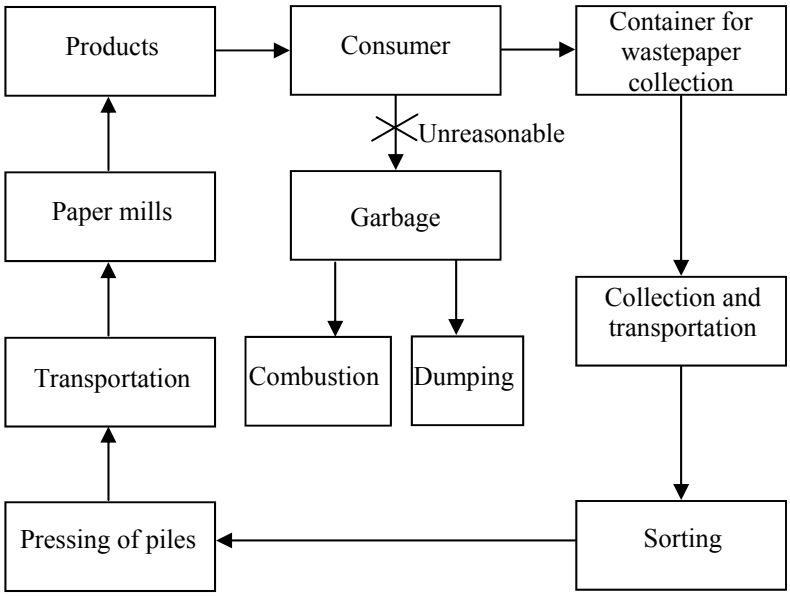

Fig. 2. Diagram of interconnections between the main elements of the wastepaper collection and processing system.

The fourth stage of wastepaper processing involves bleaching or discoloration of the fiber using bleaching agents. This operation is quite complicated and expensive; therefore, for small enterprises processing less than 100 t/day bleaching is not economically viable.

Let us pay special attention to the issues of provision, sorting, packaging, and storage of wastepaper.

The basis for efficiency of the wastepaper processing system is continuity of the product–consumer–wastepaper–product chain (Fig. 2).

There are three groups of sources of wastepaper coming for processing.

The first group includes spoilages, trimmings, sheared edges, and other waste formed directly at cardboard and paper producing enterprises. Such wastepaper is homogeneous in composition and contains almost no foreign (non-production) impurities. It is usually recycled by enterprises themselves as mill broke. As a rule, the quantity of this wastepaper type is standardized.

The second group includes various waste generated by enterprises producing goods on the basis of cardboard and paper (printing companies, producers of corrugated cardboard etc.). Such wastepaper mostly consists of products with manufacturing defects, trimmings, cutting elements, and other cardboard and paper waste. It is quite clean and homogeneous in composition. Such wastepaper is collected directly at the enterprises, after which it is packed and delivered to wastepaper processing facilities.

The third group includes wastepaper coming from different companies and enterprises, as well as from the population in the form of used cardboard and paper products. Wastepaper separated from solid household waste also belongs to this group of sources of secondary materials. As a rule, such wastepaper is not homogeneous in composition and contains large quantities of contaminants. Processing of this type of wastepaper is a sufficiently complicated and expensive process.

Wastepaper belonging to the first two groups of sources can be utilized almost entirely. Reserves for an increase in wastepaper utilization rates lie in the third group of sources, the potential of which today is far from exhausted.

Wastepaper processing enterprises are interested to receive raw materials sorted out according to grades, which allows them to manufacture quality products at lower costs. Obtainment of sorted waste is ensured in two ways: orientation directly at large suppliers of clean and homogeneous wastepaper (enterprises processing cardboard and paper, printing companies, publishing companies, chain stores etc.) and use of a network of wastepaper preparing enterprises performing sorting and cleaning of wastepaper coming from different sources.

In the long term wastepaper preparing enterprises are to become an intermediate link between paper mills and waste processing plants, which in principle can separate heavy and light fractions (mostly consisting of wastepaper) from the incoming waste.

As for packaging of wastepaper delivered to waste processing plants, there is a number of requirements specified by GOST 10700-97 State Standard.

Wastepaper should be packed in piles ranging from 200 to 600 kg in weight and containing wastepaper belonging to one grade. It is also acceptable to pack wastepaper in rolls; however, such way of packaging is found much less frequently.

The main way to deliver wastepaper to processing enterprises, located in the vicinity of industrially developed hubs with centralized points of wastepaper collection and an extensive network of motor roads, is by motor transport. In case of long distances (exceeding 500 km) between wastepaper preparing enterprises and wastepaper consumers it is transported in covered or open-top railroad cars. International wastepaper trade actively relies on ship transport. At present, a shipping route with the highest capacity lies between the United State and China (the latter is currently the largest wastepaper consumer on the global market).

Production reserves of wastepaper stored at the processing enterprise are created in order to ensure 10–15 days of continuous operation. Major types of wastepaper storage structures include open, semi-open, and sheltered storage facilities.

An alternative to dry wastepaper storage can be storage of wastepaper in liquid form. According to this method, wastepaper delivered to the enterprise is mixed with water directly in the receiving area. Then it is dissolved, cleared from large-size contaminants, and stored in specialized silos with the capacity reaching 5000 m^3.

Wastepaper is an inflammable and explosive material. The general safety requirements to wastepaper processing and the requirements to the production equipment and fire safety are regulated by the corresponding standards.

Wastepaper that became unsuitable for use due to any reasons should be transported to dumping sites approved by relevant authorities of the sanitary and epidemiological service. During processing wastepaper does not emit harmful substances into the atmosphere and does not form harmful compounds in the presence of other substances. It causes no toxic effects.

Summarizing the aforesaid, we should note that wastepaper is today and will remain in future an economically attractive raw material for manufacturing of cardboard and paper products; furthermore, wastepaper utilization is a vital economic and environmental task for the industry.

REFERENCES

1. Bondarenko, A.S., *Tsellyuloza, Bumaga, Karton*, 2010, no. 3, p. 28.
2. Dul'kin, D.A., Spiridonov, V.A., and Komarov, V.I., *Sovremennoe sostoyanie i perspektivy ispol'zovaniya vtorichnogo volokna iz makulatury v mirovoi i otechestvennoi industrii bumagi* (Current State and Prospects for Utilization of Secondary Fiber Obtained from Wastepaper in International and Domestic Paper Industry), Arkhangelsk: AGTU, 2007.
3. *GOST 10700-97: Makulatura bumazhnaya i kartonnaya, Tekhnicheskie usloviya, Gosstandart Rossii* (GOST 10700-97 State Standard: Paper and Cardboard Waste, Specifications, Russian State Standard), Moscow: Izd. Standartov, 2003, p. 7.