UDC 674.093.3

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# TECHNOLOGICAL PROCESS DESIGN OF THE LOG YARD WHEN DELIVERING TREE-LENGTH MATERIALS OF DIFFERENT SPECIES

This article dwells upon process design of the log yard where logs are prepared for sawing operations, tree-length materials being of different wood species. The sawing requirements are analyzed which enable efficient and complex use of the raw materials. The necessity to form sort groups before sawing is proved as well as the importance of debarking to obtain high-quality wood chips from lumber waste. The selection of optimal hoisting and transportation equipment is considered in the paper. It also focuses on the features of the technological processes of bucking, sorting and debarking of hardwood raw materials. The paper outlines the technological process and log yard layout.

**Introduction**. Lumbering industry is the first and main part of the woodworking industry. Annually the Belarusian woodworking industry processes over 4.5 mln. $m^3$ wood raw materials and produces about 2.5 mln. $m^3$ lumber, most of which is of commercial value. The main task of the lumbering industry is to improve the efficiency of processing saw logs by means of their rational and complex use which should then increase volume recovery of high-quality lumber that meets specification requirements. For the task to be solved, the logs should be rationally sawn according to optimal sawing schedules at the high-performance equipment. Moreover, necessary conditions should be provided to properly prepare logs for such sawing. This preparation is carried out at the log yards. The performance of the lumbering industry is highly dependent on due management of all technological processes in the yard. Such factors as inadequate sort groups by log diameter, feeding of logs with like diameters to one sawing schedule can result in lowered total and especially specified lumber recovery by 2.1–23%. No thermal treatment of logs disables their high-quality debarking in winter. No debarking of the logs, especially those affected by radioactive dust, causes radio nuclides together with bark and wood chips to enter wood boards as well as furniture pieces and our dwellings. Besides, no debarking can result in poor production standards, heavy wear and blunting of cutting tools. It also prevents wood chips from being used in paper industry to produce high-quality sulfite pulp which then has to be imported from abroad in spite of the fact that Belarus possesses sufficient amounts of pulp raw materials. All these disadvantageous factors lead to irrational use of raw materials and reduced profitability of production but they can be eliminated through innovative technological processes at log yards.

The National Program of Innovative Development of the Republic of Belarus foresees the construction of new lumber mills and modernization of the existing ones where up-to-date technological processes and high-performance equipment will be implemented not only in lumber shop but in the log and lumber yards as well. The technological processes should be upgraded not only at the large lumber mills of the "Bellesbumprom" Concern but also at middle mills of the Forestry Ministry which produce commercial lumber [1].

Many lumber mills located near logging areas organize the delivery of tree-length materials by road. The wood raw materials being delivered are of different species, including coniferous, softwood and hardwood. Improved technological processes at the log yard will enable optimal sawing of raw materials and their high-quality preparation for sawing operations.

**Main part.** To improve the quality of raw materials preparation for sawing, a technological process has been developed which enables the mechanization of block cutting, necessary sort grouping of logs and their debarking. So, the following basic loading, transportation and technological operations are to be carried out: discharge of tree-length materials, stocktaking of tree-length logs, block cutting of logs, sorting of logs by grade, species and diameter, stocktaking of sorted logs, hydrothermal treatment, debarking and supplying of logs to the lumber shop. The sequence of technological operations by the delivery of tree-length materials of different species is shown in Fig. 1 [2]. Meanwhile hardwood logs go to debarking and sawing without being dumped into a log pond as their specific weight is close to that of water and there is a risk of their sinking. To discharge treelength logs and their cutting, special equipment is provided: a heavy-duty crane and ЛО-15А treelength bucking plant. The delivery of treelength materials also requires special equipment to be used in the yard for discharge and transportation. Large mills use portal, knee-type frame and bridge heavy-duty cranes: ЛТ-62, ККЛ-32, КМ-3001 or discharge and bucking plants. Low-capacity mills producing up to 50 thousand $m^3$ per year, discharge and bucking plants are used which usually contain discharge-separating units of ЛТ type (ЛТ-74) and bucking units like ЛО-15А, ЛО-68 and МР-8. The technological process takes into account that fact that treelength logs should be fed butt-forward when bucking, but top-forward when sorting.

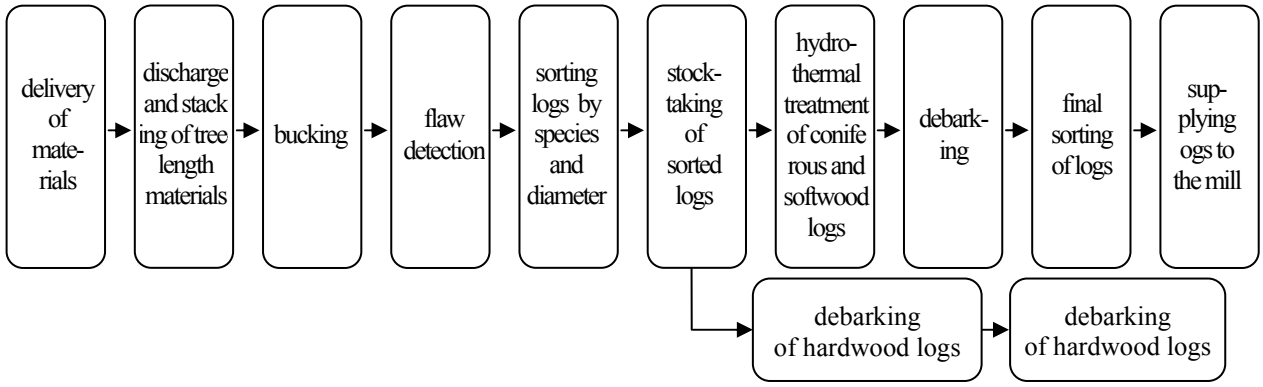


Fig. 1. Technological operations by the delivery of tree-length materials of different species and preparation of logs for sawing

These requirements were considered in the proposed layout of technological processes in the log yard.

The layout of technological processes proposes high-performance heavy-duty ЛТ-62 frame crane (32 t) to be used for discharge of tree-length materials. The sequence of technological processes in the tree-length logs dump area is shown in Fig. 2.

ЛО 15А unit is employed for debarking that contains two manipulators used to mechanize tree-length logs supply to two-chain logway carrying them to swing bucksaw. The logs obtained are then carried to a sorting belt by means of a log kicker, a log elevator and a single-log delivery mechanism. The logs are then delivered with a certain interval which enables their right assessment, sorting and dumping to timber pockets. In the log sorting area cranes of different types and wheeled loggers (made by "Amkodor" company) serve as main loading equipment. The loading equipment is chosen on the basis of the volumes of the raw materials being handled, ways and schedules of delivery [2].

Knee-type frame cranes of 8–15 t lifting capacity, 32–40 m span and 8–15 m cantilever span are the most reasonable to be used at middle-sized mills processing 60–150 thousand $m^3$ wood raw materials per year. These cranes have relatively high performance and can be used both for hoisting and transporting operations when dumping the raw materials, unloading timber pockets at sorting belts and transporting log bundles at small distances. They also ensure even piles of logs without overhanging as the crane operator is located directly over the piling area. Chain grapples are used to take, transfer and pile a bundle of logs. Cross-section view of technological processes in the log sorting area of the log yard using a crane is shown in Fig. 3.

Debarking of logs is one of the main operations in the course of preparation of materials for sawing. Debarking is extremely essential for the woodworking industry of Belarus as it has large territories contaminated by radio nuclides. Sand and dust are carried by the wind over large areas depositing and remaining in the bark of trees. The bark comprises about 10% of the tree trunk and its specific weight can make up to 40% of woodchip. If bark is not removed before sawing, it will be integrated in the wood boards, furniture and other wood chip-based products [3].

Debarking is often not carried out because it is practically impossible to make high-quality debarking of logs in winter without preliminary hydrothermal treatment, log treatment ponds at mills being absent or used for other purposes. The mill log ponds are intended to make necessary buffer stock of logs between raw materials storage, barking and sawing shops where the logs are washed, their surfaces are thawed before barking and they are thoroughly sorted by diameter.

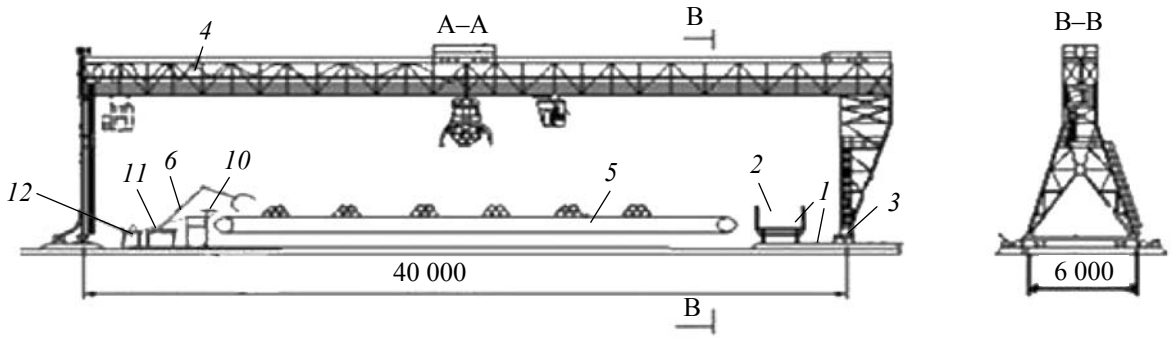


Fig. 2. Sequence of technological processes in the tree-length logs dump area using ЛТ-62 frame crane. See keys in Fig. 4

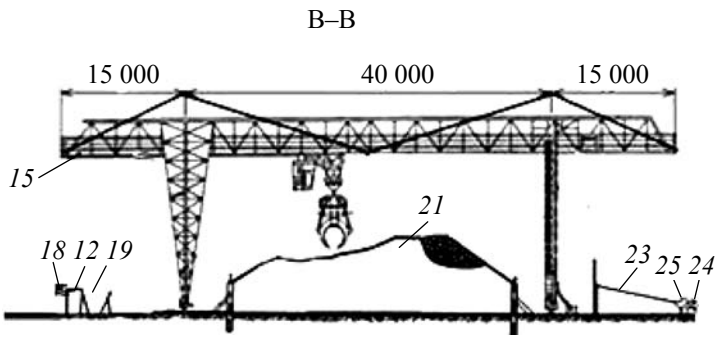


Fig. 3. Cross-section view of technological processes in the log sorting area of the log yard using a knee-type frame crane. See keys in Fig. 4

Mechanical means applied at the log ponds include: accelerators which carry the logs from pockets to yards and mechanisms which push the logs onto log chains. The log accelerators can be of several types: rope, drum and hydraulic. These different equipment types allow to mechanize operations at the log ponds in different ways [4]. Coniferous and softwood logs are supposed to undergo hydrothermal treatment of logs and their subgrading in the mill log ponds while hardwood logs will be carried to debarking and sawing operations without being dumped in the log ponds due to the risk of their sinking.

Bucking of hardwood tree-length materials is done with regard to the fact that high-quality materials should be processed into crossband veneer. The length of wainscots to produce crossband veneer is 3.2–3.3 m, so assortments of this length are usually produced from hardwood tree-length materials. The given data allow to outline the technological process at the log yard of a middle-sized saw mill that processed as much as 150 thousand $m^3$ wood raw materials of different species annually (see Fig. 4).

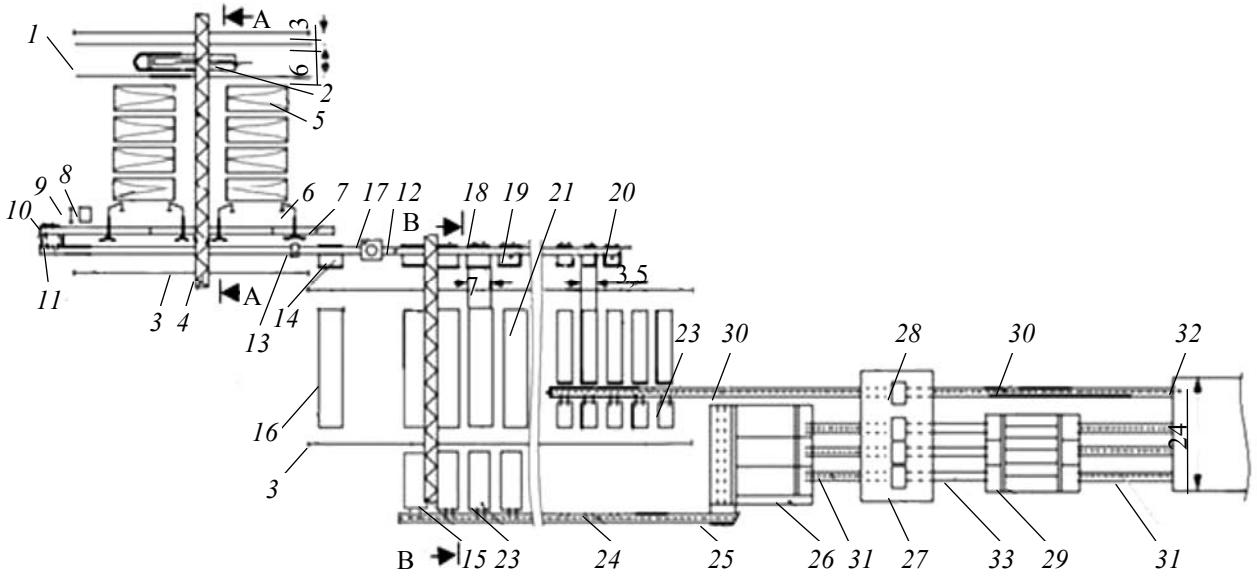


Fig. 4. Technological process at the log yard with the delivery of wood raw materials of different species, with debarking operations and log ponds for thawing and subgrading:
1 – tree-length materials hauling road; 2 – timber carrier; 3 – crane runway; 4 – ЛТ-62 unloading crane; 5 – log storage; 6 – manipulators; 7 – longitudinal two-chain logway; 8 – control panel of log cutting; 9 – swing crosscut saw; 10 – assortment kicker; 11 – log elevator with single-log discharge mechanism; 12 – log sorting belt; 13 – flaw-and-metal detector; 14 –pocket for inferior logs; 15 – knee-type frame crane; 16 – inferior logs pile; 17 – control panel of log grading; 18 – log kickers; 19 – pockets for coniferous and softwood logs; 20 – pockets for hardwood logs; 21 – piles of graded coniferous and softwood logs; 22 – piles of graded hardwood logs; 23 – accumulating site with single-log discharge mechanism; 24 – longitudinal chain logway; 25 – lever-type log kicker; 26 – thawing log pond; 27 – debarking shop; 28 – debarking machine; 29 – subgrading log pond; 30 – hardwood logs transporter without dumping to log ponds; 31 – logways; 32 – sawing shop; 33 – laying chute for supplying debarked logs to the log pond before sawing

**Conclusion.** The suggested process solutions made it possible to outline the technological process when delivering tree-length logs of different species. The suggested solutions ensure:

1) complex mechanization of all technological, hoisting and transporting operations;

2) proper preparation of logs to cutting operations, rational, complex and efficient wood processing due to necessary sort grouping by each even diameter, log debarking before sawing, hydrothermal log treatment before debarking in winter, bucking and grading of hardwood assortments according to their quality and use.

The results obtained can be used in the teaching process as well as in the production process when designing and modernizing log yards of sawmills.

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*Received 15.03.2012*