The use of mobile debarking equipment as a basis for rational environmental management

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Abstract. The paper analyzes of the problem of rational nature management in the process of logging operations. An assessment of the formation of logging waste in the form of branches, twigs and twigs is given. The expediency of their processing directly in the places of their accumulation into technological chips is substantiated. In order to debark branches, twigs and twigs before processing into technological chips in logging conditions, a design of a mobile debarking plant was proposed. To achieve this goal analytical and mathematical methods were used, as well as modeling of the structures of units and assemblies. The results obtained can be widely used both at logging and wood processing enterprises. The use of the proposed design of a mobile debarker together with a chipper in the process of logging operations will reduce the amount of logging waste by removing technological chips from branches, branches and twigs from the cutting area.

1 Introduction

Today, the close attention of the entire timber industry complex is focused only on the processing of sawmill waste, while logging waste can and should be used as an additional raw material for advanced wood processing enterprises. The dominant reason for the lack of interest in logging waste is the poorly developed direction of scientific research on the processes and phenomena that occur during the processing of branches, branches and twigs.

It is known that from the point of view of logistics, it is most rational to process raw materials in the places of their formation, which is confirmed by the transportation costs to the place of processing. As a result, it is most expedient to process wood waste in the form of branches, branches and twigs directly in the places of their formation, that is, in the cutting area. One of the most rational ways of processing logging residues is the production of process chips in mobile chippers.

It is acknowledged that technological chips serve as a raw material in the pulp and paper and woodworking industries for the production of containerboard, technical grades of paper, and fibreboard. In the process of processing wood chips technological energy-chemical method produces gas, esters, acids, coal, aldehydes, resin, alcohols. Also, technological chips have found application in hydrolysis production. It has been established that the main

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requirement for technological chips, along with the geometric dimensions and moisture content, is the limited content of bark and mineral impurities.

2 Materials and methods

Table 1 shows the characteristics of chips corresponding to TU 13-735-83, GOST 17462-77, GOST 15815-83, according to which the quality indicators of raw materials from branches, branches and twigs are evaluated [1-3].

Table 1. Chip quality indicators.

Type	Length, mm	Thickness, mm	Cut angle, deg.	Mass fraction of bark, %	Mass fraction of rot, %	Purpose
Technological chips	12-15	before 5	30-60	1 1.5 3	- 0.3 0.3	Pulp and paper industry
	10-35	before 5	30-60	15	5	Fibreboard production
	10-60	before 30	30-60	15	5	Production of particle boards
Fuel chips	5-50	before 10	-	20	5	Burning
Small chips	15-30	before 5	-	-	5	Feed additive, litter and compost

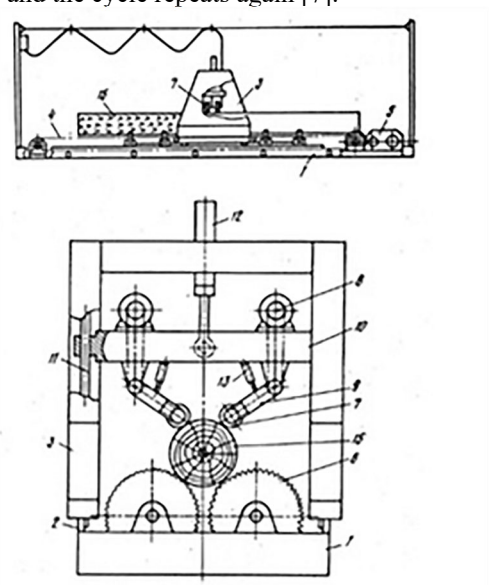
The results of the analysis of the experiment are presented in Table 2. They show that chips can be classified as technological if they are obtained from the top part of the trunk and small branches of pine, as well as large branches of birch, pine and spruce [1].

Table 2. Results of experimental studies.

Tree species	Type of waste	Diameter, cm	Type of wood chips
Pine	Tops	5-16	Technological
	Small branches	4-10	Technological
	Boughs are large	more 10	Technological
	Branches	before 4	Small
Spruce	Tops	5-16	Small
	Small branches	4-10	Small
	Boughs are large	more 10	Technological
	Branches	before 4	Small
Fir	Tops	5-16	Small
	Small branches	4-10	Small
	Boughs are large	more 10	Fuel
	Branches	before 4	Small
Birch	Tops	5-16	Fuel
	Small branches	4-10	Small
	Boughs are large	more 10	Technological
	Branches	before 4	Small

As a result, the question arises of developing a design for a mobile debarking plant for separating bark and mineral impurities from wood of branches, twigs and twigs.

An analysis of literary sources showed that today, milling, rotary and drum debarking machines are widely used [4-6]. So, in Figure 1, a diagram of a milling debarker is presented. As can be seen from the diagram, the U-shaped frame is equipped with vertical guides, the mechanism for lifting the levers of the debarking heads 15 is fed to the corrugated discs 6, with the inclusion of the drive of the latter, it starts to rotate. As a result of the operation of the hydraulic cylinder 12, the traverse 10 and the debarking heads 7, rotated by the electric motors 8, are lowered onto the log, which performs rotational movements. When the rotating heads touch the surface of the log and the synchronous activation of the drive frame 3, the process of barking occurs. Hydraulic cylinders 13 with shock absorbers 14 integrated with them produce the necessary pressing force of the heads against the log. After barking, the log is dropped from the device and the cycle repeats again [7].



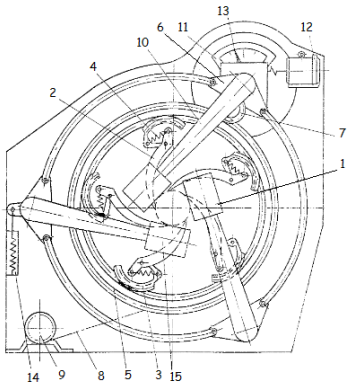
1 - bed; 2 - horizontal guides; 3 - U - shaped frame; 4 - thrust; 5 - drive; 6 - corrugated discs; 7 - debarking heads; 8 - electric motors; 9 - hinged levers; 10 - movable traverse; 11 - vertical guides; 12, 13 - hydraulic cylinders; 14 - built-in shock absorbers; 15 - log

Fig. 1. Scheme of a milling debarker [7].

The log to be debarked is fed onto the corrugated disks, with the inclusion of the drive of the latter, it begins to rotate.

The disadvantage of this design of the debarker is that for its efficient operation it is necessary to strictly centre the axis of the log in the vertical plane.

The scheme of the rotary debarker is shown in Figure 2. The feed rollers 16 receive rotation to feed the whips into the debarking machine through the shaft 23, the bevel gear 24, the shaft 25, the gearbox and reverse 26, from the shaft 11. The feed rollers 16 are pressed against the log using a spring damping device 27. Kinematics of communication between the rotor 1 and the rotary ring 5 can be selected in such a way that the angular speed of their rotation will be the same when the carrier 9 of the differential mechanism is stationary, and therefore, when the trunk 15 of the feed rollers 16 is stationary [8].



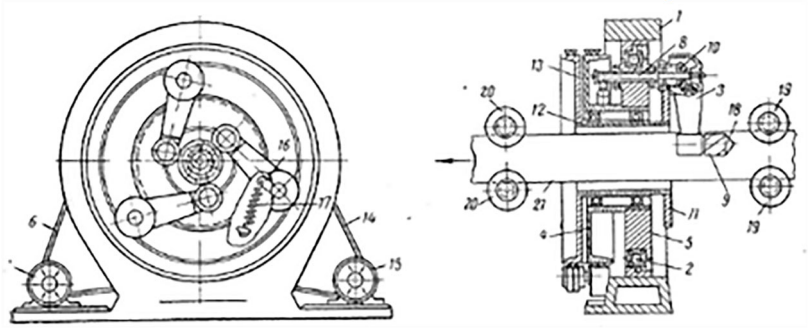
1 - rotor; 2 - sickle-shaped bark removers; 3 - gear sectors; 4 - connecting elements; 5 - rotary rings; 6 - gears; 7 – crown wheel; 8 - clinomeric gear; 9 - electric motor; 10 - trunk; 11 - scale; 12 - electric motor; 13 - pointer arrow; 14 - spring damping device; 15 - rollers.

Fig. 2. Scheme of a rotary debarker [8].

The principle of operation of the debarking machine is that the electric motor through the clinomeric transmission drives the rotor and through the gear the hollow shaft, the sun wheel, satellites, the crown wheel of the differential mechanism, the swivel ring. In this case, the kinematics of the connection between the rotor and the rotary ring is chosen in such a way that they rotate in the same direction with the same angular velocities when the carrier is stationary. Together with the rotor and the swivel ring, the associated pullers rotate. With the help of a gearbox and a reverse through the bevel gear shaft, the required rotation speed is reported to the feed rollers to feed the logs into the debarker. Before the log is fed into the machine, the feed rollers are tied to the center of the rotor to the stop using a spring damping device.

The disadvantage of this type of debarking machine is the low quality of processing and the complexity of the design.

On Figure 3, a diagram of a drum debarker is presented. Consider a brief principle of operation of this model of the debarking machine. The machine is started by the engine. The ring gear of the drive of cylindrical cutters is fixed on a drum installed in the annular rotor of the machine. Each cutter has a conical nozzle located on the side of the log feed [9].



1 - bed; 2 - bearing; 3 - heads; 4 - pulley; 5 – ring rotor; 6 - clinomeric gear; 7 - engine; 8 - roller bearings; 9 - cylindrical cutter; 10 - gear; 11 - ring gear; 12 - drum; 13 - pulley; 14 - clinomeric gear; 15 - engine; 16 - levers; 17 - tension devices; 18 - cylindrical nozzle; 19 - feed rollers; 20 - extracting rollers.

Fig. 3. Drum debarker [9].

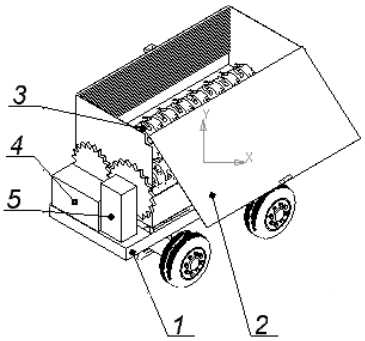
The main disadvantage of this type of equipment is the difficult supply of raw materials to the debarking machine.

As the analysis of the design features of the existing debarkers showed, they are all stationary equipment not suitable for work in logging conditions.

As a result, the purpose of this research was to develop the design of a mobile debarker for debarking logging waste in the form of branches, twigs and twigs.

3 Discussion and results

In order to develop the design of a mobile debarker for branches, branches and twigs in the Compass 3D system, its model was developed, presented in Figure 4.



1 - wheelbase; 2 - body with a folding board; 3 - working shafts; 4 - power take-off with gearbox

Fig. 4. Model of a mobile debarker for branches, branches and twigs.

It can be seen from the model of the mobile debarker shown in Figure 5 that branches and twigs with separated tree greens are loaded through the top of the housing 2. The rotation from the internal combustion engine is transmitted to the shafts 3 through the means of the power take-off 4, as well as the gearbox 5. The working shafts are made with a slotted notch, on which the washers with teeth, shown in Figure 5. After debarking a batch of branches, branches and twigs, the rotation of the working shafts stops, the tailgate of the device opens, and the debarked wood is removed from the body. The separated bark in the process of operation of the device falls through the slots at the bottom of the device.

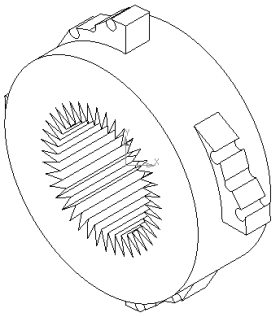


Fig. 5. Model washer with teeth.

4 Conclusion

Thus, in the course of the research, an assessment was made of the need to process logging waste in the form of branches, branches and twigs into technological chips. The relevance of the development of a mobile debarking device is substantiated. The analysis of existing designs of debarking machines is carried out. The design of a mobile debarking machine for branches, branches and twigs is proposed

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