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PERSPECTIVES AND FEATURES OF BRANCH UTILIZATION TECHNOLOGIES IN INTENSIVE GARDENS AND PARKS

In most countries of Europe and North America, wood chips obtained in the process of cutting brushwood and branches are widely used in intensive gardens and parks as a mulching agent. Technologies that involve the disposal of branches have a wide list of technological operations. One of the most common involves manual pruning with the help of simple technical tools such as a chainsaw and cordless saws. The cut wood is transported and piled into piles, which are burned when there is enough accumulation. This technology is primarily environmentally harmful, as it pollutes the environment. Therefore, the property of using chopped branches as mulch between rows in gardens and park alleys is quite an important factor.

The goal is to study the application of the technology of cutting branches into chips with a high-tech unit, which will make it possible to reduce labor costs by approximately 1.5 times, fuel costs by 1.4 times, eliminate environmental pollution, replenish the soil with organic and mineral additives and use additional areas of land. which are now set aside for wood burning sites.

Technologies that involve the disposal of branches after trimming the crown of trees have the most diverse directions of use of the pruning product and a wide list of technological operations. Each of them is interesting in its own way, has advantages and disadvantages, and therefore requires more detailed coverage.

One of the oldest and most primitive technologies involves manually loading cut wood onto vehicles, taking the branches to storage sites, where they are burned. This technology is poorly mechanized and requires extensive use of unproductive manual labor. The coefficient of utilization of the carrying capacity of vehicles is very low, as it is impossible to place the collected wood tightly under load. Currently, it is used in small farms.

Keywords: *technology, wood, alternative energy sources, mulching, garden, orchards, brush, shredding, aggregate.*

Introduction. The technology using a combine harvester for simultaneous contour pruning and wood grinding, developed at the Institute of Horticulture of the Ukrainian Academy of Sciences, deserves attention. In the first version, the branches cut by the disc saws of the machine fall on the conveyor, which feeds them to the shredding drum [1]. With the help of a fan, the chopped chips are fed into the hopper, which, after filling, is unloaded into vehicles, which take this wood outside the garden. In the second option, the wood chips are spread between the rows. The use of a harvester makes it possible to combine several technological operations and exclude the removal of whole branches [1].

Well-known and more widespread technologies: shredding of cut branches directly between the rows of the garden by mobile shredders with the loading of chips into a hopper, their removal from the garden, the use of wood for making compost and then spreading it in the garden [2].

In 1986, scientists compared the most common technology with a number of others, which involved shredding the collected wood outside the garden on cage roads and directly in the rows of the garden with mobile shredders. It is noted that it is economically more expedient to use the selection and crushing of branches directly in the rows of the garden with even more expensive and less productive mobile pick-up-shredders, than to simply collect the mass on inter-cage roads with branch pick-ups that are simple in design.

There are many ways of using cut branches. Collected wood, after appropriate processing, can be used to prepare composts, in the woodworking industry for the production of wood boards; in the hydrolysis industry for the production of fodder yeast, which is used as an additive in animal rations. For comparison, the feed value of 1 kg of completely dry straw is 0.2 - 0.25 feed units, and branches with a diameter of up to 40 mm are 0.25 - 0.4 feed units. The wood of branches can also be used as fuel for heating greenhouses or drying fruits. But all these disposal methods require additional technological costs. Domestic and foreign researchers note that 1 ton of wood contains the same amount of dry matter as 2 tons of manure. It is also known that every 100 tons of crushed mass can give the soil up to 450 kg of nitrogen, more than 80 kg of phosphorus and about 500 kg of potassium [3].

The agro-requirements presented by the Institute of Horticulture of the Ukrainian Academy of Sciences for the mobile shredding of tree branches determine that the length of the main mass (at least 80%) of the chopped branches should not exceed 150 mm, based on the conditions of free passage, without clogging, working bodies of tillage machines and rapid decomposition of fruit wood. For quick decay of the cuttings, it is necessary to dig immediately after grinding to a depth of 7-12 cm in the most biologically active layer of the soil.

If crushed wood particles are used as mulch in tree trunk strips, it will increase the biological activity of the soil, increase its ability to retain moisture, and stimulate the development of nitrogen-fixing bacteria and fiber-decomposing microbes. Plants will absorb mineral fertilizers better, and the growth of weeds under the layer of mulch slows down.

It is also noted that the application of crushed wood chips in the form of mulch to the surface of the soil will help solve the issue of processing and using wood waste, and will allow valuable organic material to be returned to the cycle of substances. The mulch itself, like a layer of straw, preserves soil moisture, and the content of humus in the soil increases.

Recently, intensive compacted gardens, which have already gained recognition abroad, are becoming more and more common in Ukraine. Gardens of this type compared to ordinary ones have advantages in terms of fruit quality, early fertility, yield (for comparison: the yield of apples in such gardens s reaches 350 - 500 t/ha, when in ordinary type gardens it is 150 - 200 t/ha) and culture of care after them. The width between rows of compacted gardens ranges from 3 to 5 m, and the distance between trees in a row is 1-2 m. In such planting schemes, trees on dwarf rootstocks are used. The use of this type of tree is directly reflected in the geometric dimensions of the branches that are cut during the maintenance of the crown of the compacted garden (according to our data, the maximum diameter of the branches in the cut plane does not exceed 30 mm). Both the diameter and the length of these branches are significantly smaller compared to the branches that are cut from the crown of trees in gardens of the usual type [3]. This creates favorable conditions for their grinding using single-stage grinders with simple structural and technological schemes.

Analysis of recent research and publications. In the mechanized technology of utilization of branches of fruit trees and bushes cut during planned cleaning of plantations, the most widespread and important is the process of their grinding, the quality indicators of which are determined by agrotechnical requirements.

The technological process of grinding is very complex and depends on a number of factors: the physical and mechanical properties of materials (size, shape, moisture, strength), the type of grinders, their working organs and the mode of operation of the machine. In engineering terms, chopping branches is the most energy-intensive operation. During the grinding of wood waste, the energy consumption is 20 - 27 kJ/kg.

Crushing is the separation of a solid body into parts due to the application of external forces, when internal stresses exceed its strength limit.

Depending on the method of action of the working body on the branches and the type of deformation that occurs in the wood, grinding is carried out mainly by a combination of blows with the use of hammers, knives and cutting due to sharpened working bodies (knives).

The foundations of the theory of grinding due to knives are laid down in the works of scientists [1-3, 5, 7, 9-14]. The research describes the process of material grinding in the chamber, the dynamics of the grinding drum, the aerodynamics of the grinder and the energetics of the process.

But the results of these studies cannot be directly used to calculate the rational parameters of mobile shredders, which are designed to shred branches and wood waste for their disposal. This is due to the difference in physical and mechanical properties of materials and structural and technological features of shredders [4-6].

Branches and wood as a whole are an elastic-viscous-plastic material with clearly expressed anisotropy, the specific feature of which is the presence of a structure: a frame with elastic and plastic properties and an aggregate with viscous properties.

Among the works on the study of the development of deformation and stress relaxation in the plastic region of organic matter, the leading place is occupied by the works of the Ukrainian academic F. Belyankin, in which it is noted that when crushed, the viscous resistance forces of the aggregate increase. Therefore, for the destruction of wood, it is necessary to apply a much greater load, compared to what is sufficient for destruction by static forces. The increase in destructive forces during the increase in the speed of their application is noted in [3-5].

Many scientists have studied the process of shredding wood waste with mobile shredders, but until now, the issue of optimizing the modes of operation of the shredder when shredding wood waste with mobile shredders, from the point of view of joint consideration of quality and energy indicators of the process, has been little theoretically investigated, although it is of great scientific and practical interest.

Professor I. Revenko described the balance of energy expenditure A for crushing material in a closed-type hammer crusher with the following equation [7]:

$$\mathrm{A} = \mathrm{A}_{\mathrm{g}} + \mathrm{A}_{\mathrm{c}} + \mathrm{A}_{\mathrm{con}} + \mathrm{A}_{\mathrm{т}}, \qquad (1)$$

A_{g} - energy consumption for grinding itself, which depends on the properties of the material and the degree of its grinding (determined by the formula of C. Melnikov); A_{c} - energy consumption for separation (overcoming the resistance of the grating surface during sieving of the product); $\mathrm{A}_{\mathrm{con}}$ - energy consumption for moving material in the working chamber; $\mathrm{A}_{\mathrm{т}}$, - energy consumption for transporting the product to the receiver.

According to research data [6,8,9], the total energy consumption of a shredder for shredding wood waste consists of energy consumption: for the destruction of wood waste - A_{dest}; on the compression of wood by a shredding device before its destruction - $\mathrm{A}_{\mathrm{СТ}}$; for transporting particles from the shredder - $\mathrm{A}_{\mathrm{тр}}$ and on its idle speed - A_{XX}:

$$\mathrm{A} = \mathrm{A}_{dest} + \mathrm{A}_{\mathrm{ст}} + \mathrm{A}_{\mathrm{тр}} + \mathrm{A}_{\mathrm{xx}}, \qquad (2)$$

The power balance of a mobile rotary shredder with sharpened working bodies when shredding wood waste is calculated according to the equation [7]:

$$75N = A\omega + B\omega^3 + A_{gr} + K_{sc} + B_{\mathrm{м}} + V_{\mathrm{м}}\psi(\lambda - 1) + \frac{qV^2}{2g}, \qquad (3)$$

A, B - empirical coefficients; A_{gr} - specific work of grinding; ω - angular velocity of the rotor, rad/s; ψ - specific weight of the roll, gr./m3; *q* - material supply, kg/s; B - the machine's grip width, m; VM - working speed of the machine, m/s; λ - degree of grinding; K_{sc} - splitting coefficient; V - material grinding speed, m/s.

The most complete power balance of grinding coarse forage of the hammer type is presented [7]:

$$N = N_{gr} + N_{ov} + N_{\mathrm{p}} + N_v + N_{\mathrm{xx}}, \qquad (4)$$

$N_{\text{и}}$ - the power consumed in the process of grinding the stalks at the entrance to the grinding chamber; Nд and Np - the power consumed in the process of overcoming the friction of the particles of the circulating layer against the loaded part of the hammers, respectively, in the areas of the deck and the sieve; N_v - the power consumed in the process of hitting and giving speed to feed particles.

In order to determine the power consumption directly for the coarse forage grinding process itself, the value of the probability $P_{\text{в}}$ of stalks hitting the adjacent row of knives is additionally entered into the formula, which makes it more accurate and replaces work A, which is spent on destroying one stalk with an average effort $P_{рср}$ [7]:

$$N_{des} = 0.001P_{\mathrm{рср}}\frac{2Q_{\text{и}}\pi R_{\mathrm{р}}}{G_{\mathrm{ст}}K_{\mathrm{р}}}\left(\frac{L_{\mathrm{ст}}}{l_{\mathrm{ср}}} - 1\right)P_{3}, \qquad (5)$$

$Q_{\text{и}}$ - crushing productivity, kg/s; Gst - average weight of one stalk, kg; Rp - radius of the rotor at the ends of the knives, m; Lst - length of stems, m; Kp - the number of rows of knives; lcp - average length of crushed particles, m.

The following two terms of the formula for determining the total power can be determined by formulas that are similar to each other:

$$N_{dt} = 0.00025\frac{Q_{\text{и}}V_{\mathrm{в}}S_{\mathrm{м}}n_{\mathrm{мр}}K_{\mathrm{р}}L_d}{\pi R_{\mathrm{р}}h_s L_{\mathrm{к}}V_{sl}}ʄ_{tr}\ , \qquad (6)$$

$V_{\mathrm{в}}$ - relative speed of knives, m/s; S_m - surface area of the loaded part of the knife in the material layer, m2; nmr - the number of knives in one row; Ld - length of deck, m; hs - thickness of the circulating layer, m; Lk - width of the grinding chamber, m; Vsl - speed of the material layer in the shredder chamber, m/s; ʄtr - coefficient of friction of mass movement on the steel surface.

The power consumed in the process of hitting and giving speed to feed particles:

$$N_v = 0.001P_{ydt}\frac{Q_{\text{и}}\pi R_{\mathrm{р}}\varphi V_{\mathrm{о}}}{180V_{sl}}P_{if}, \qquad (7)$$

P_{if} - specific impact force, N/kg; φ - angle of girth of the soundboard.

Based on the above review, it can be noted that each of the scientists determines the power balance equation using the formula for the threshing drum and at the same time strives to specify its components under the conditions of their process and based on research objectives [8-11].

The study of the stability of the movement of hammer crushers established that when designing them, it is necessary to take into account not only the geometry and mass of the hammers, but also the ratio between the dimensions of the hammer and the rotor. In the absence of balancing of the hammer on impact during grinding of materials, the impact impulse is transmitted to the bolt, which hinges the hammer to the rotor disk; from the bolt to the disk, from the disk to the rotor shaft and bearings, which leads to rapid wear of the entire shredder and its inefficient operation. By balancing the hammers on impact, it is possible to free the machine from impact reactions in the connections [10].

According to the theory of impact balancing of hammers, to eliminate impact reactions, it is necessary that the square of the radius of inertia of the hammer ρ2 relative to the axis of its suspension is equal to the product of the distance c from the given axis to the center of mass of the hammer by the distance from the same axis to the line of impact l [8]:

$$\rho^2 = c, \tag{8}$$

Along with this, it is shown in the works that the hinged hammer of the grinding devices is periodically affected by the forces associated with grinding the mass, which cause the hammers to deviate from their radial position. These authors proceed from the fact that when the rotor rotates with a horizontal axis of rotation under the action of centrifugal forces, the hinged hammers are set in a radial position and maintain their position until they meet the material being crushed. After interacting with the material, the hammer is deflected by a certain angle, making free oscillations in the field of centrifugal forces relative to its radial position. The most effective grinding occurs under the condition that at the moments of subsequent meetings of the hammer with the grinding material, the direction of relative rotation of the hammer in its oscillating motion near the axis of the suspension coincides with the direction of rotation of the rotor. In this case, the speed of grinding is equal to the sum of the speeds of relative and transfer movement, while reaching its maximum value. Therefore, the most advantageous position of the hinged hammers during their next meeting with the material being crushed and ensuring the appropriate selection of the design parameters of the hammers and the rotor. This condition is determined by the [8]:

$$\sqrt[\lambda]{\frac{I_a}{mcR}} = 1\,, \tag{9}$$

I_a - moment of inertia of the working body relative to the suspension axis, m;

R - the radius of the suspension of the working body - the distance from the axis of the rotor to the axis of its suspension, m;

c - distance to the center of mass of the working body from the axis of its suspension, m; m is the mass of the hammer, kg; λ is a positive number$\left(\frac{1}{2}, \frac{3}{2}, \frac{5}{2}\right)$.

The given equality determines such a relationship between the parameters of the rotor, in which during the interaction of the working bodies with the material, the angular velocity of the hammers' oscillations coincides in direction with the angular velocity of the rotor, at its maximum value. As we can see from the expression that at any angular speed of the rotor, the required ratio will be preserved, and it depends only on the geometric parameters of the latter.

There are different judgments both when choosing the design parameters of the rotor and when determining the rational weight of the hammer. Thus, in order to reduce the energy consumption associated with the oscillation of the hinged hammers of the chopper rotor when grinding the vines, it is recommended to use a rotor with a light drum and sufficiently heavy hammers.

Many scientists in their works also prefer threshing drums with a smaller diameter and moment of inertia [10]. It is noted that a drum with a large moment of inertia works more calmly, that is, it develops and loses its speed more slowly than a drum with a small moment of inertia. With a small number of revolutions, a large drum will work quite well even with a weak engine. It is noted that by increasing the diameter of the rotor, it is possible to reduce its rotation frequency and thus reduce vibrations and dynamic loads in the machine. It was determined that in order to reduce the power consumption in brush cutters - shredders with a rotor rotating in a horizontal plane, a flywheel is installed. When grinding corn, a rotary grinder with heavier hammers had lower specific power consumption and better performance indicators (smaller average length of crushed particles) than when using lighter hammers [10-14].

The authors of the work suggest increasing the mass of the hammers, which will automatically reduce their angle of deviation from the radial position when the material is crushed. This factor, along with an increase in the radius of the working chamber, leads to an increase in the angle of attack of the working bodies, which, in turn, has a positive effect on the efficiency of the hammers when crushing mass by impact.

When researching the grinding process on hammer crushers of viscous-plastic materials), which includes wood, the authors prefer sharp knives compared to ordinary (blunt) working organs. With sharpened knives, the material is crushed mainly as a result of the shock-cutting action of the working bodies with grinding elements. The use of such working bodies sharply reduces the energy consumption of the process, more uniform grinding of the material is achieved [12].

Materials and methods. In the work, when comparing options for the execution of the working chamber of a hammer crusher, compared to open-type machines. Preference is given to crushers in which the working chamber is closed with sieves. The latest crushers have better performance indicators and almost do not differ in performance and energy consumption from open type crushers. As a conclusion, it can be noted that the results of the above studies cannot be directly used to justify the rational parameters and modes of operation of mobile hammer shredders, which are intended for shredding branches and wood waste. is related to the difference in the physical and mechanical properties of wood and grapevine waste, grain and stalk fodder and the variety of design features of shredders, their working bodies and modes of operation. But from the known studies, it is possible to use some approaches, methods and theoretical provisions to substantiate the process of shredding branches and wood waste. The rational value of the necessary speed of the working bodies of hammer grinders must be determined comprehensively, taking into account its influence on all indicators of the machine (technological, energy and quality).

The goal is to study the application of the technology of cutting branches into chips with a high-tech unit, which will make it possible to reduce labor costs by approximately 1.5 times, fuel costs by 1.4 times, eliminate environmental pollution, replenish the soil with organic and mineral additives and use additional areas of land. which are now set aside for wood burning sites.

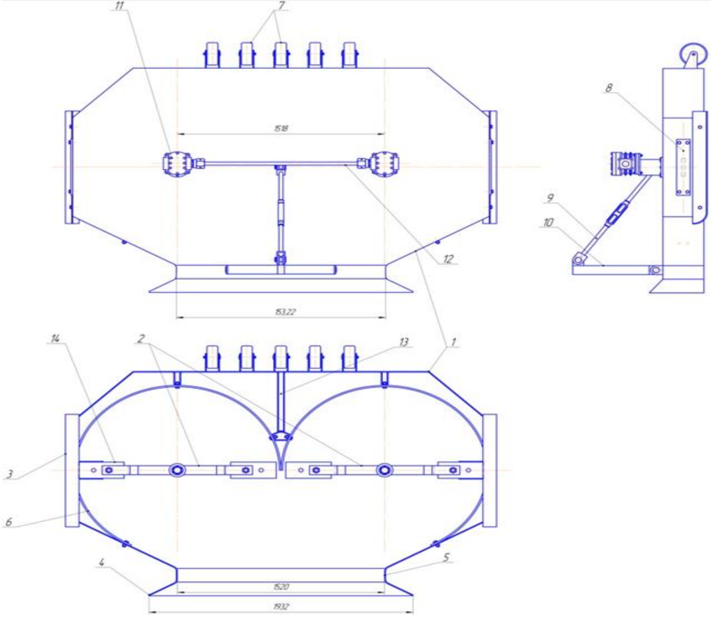

Fig. 1. Structural and technological scheme of the unit for processing brushwood: 1 - body; 2 - rotor rod; 3 - skiing; 4 - fairing; 5 - inlet; 6 - lattice; 7 - supporting wheel; 8 - counter hammer; 9 - traction; 10 - three-point hitch mechanism; 11 - hydraulic motor; 12 - hydraulic hose; 13 - lattice fastening; 14 - hammer.

Hammers, which have a pointed chamfer (edge), hit the branches, while, depending on the size of the branches and their position, the following is done:

a) separation of branch particles and their movement along the tangent paths of the hammers at the indicated points into the working chamber;

b) transfer of branches into the working chamber due to impact action of hammers.

Particles of chopped wood freely fall from the chamber to the soil surface if their size is smaller than the gap between the bars of the grid and they have the appropriate orientation in space. Otherwise, the branches or their particles fall into the opening between the face of the hammers and the counter hammers (Fig. 1) [4,6], where their support grinding is performed. Further transportation of wood is carried out under the action of hammers to the exit through the gaps between the lattice bars. In addition, insufficiently crushed wood particles circulate in the working chamber, splitting between the surface of the grid and the face of the hammers and again and again falling under the blows of the working bodies, until their length reaches the appropriate dimensions to pass freely between the bars of the grid. With such a technological scheme of the device, the main grinding of branches takes place mainly when they enter the grinding chamber, and in the chamber itself - cases of unsupported grinding of wood, and grinding using counter hammers - supported grinding, as well as as a result of pulling the mass along the surface of the grate.

The unit for crushing brushwood is aggregated with tractors with a power of 120-135 HP. Valtra G 135 type with a pump capacity of 110 l/min.

Selection and calculation of hydraulic drive elements. High-speed filming shows that in hammer crushers, which are used for chopping wood, the destruction of branches takes place due to the free impact of the hammer and during the impact of particles on the deck (rackets) or counter hammers.

For the proposed technological scheme, the main grinding of branches occurs mainly when they enter the grinding chamber, unsupported grinding of wood and the use of counter hammers, supported (Fig. 1), as well as as a result of pulling the mass along the surface of the grid. The total power required to perform the process of chopping wood with a two-rotor mobile branch chopper is determined from the following histogram (Fig. 2):

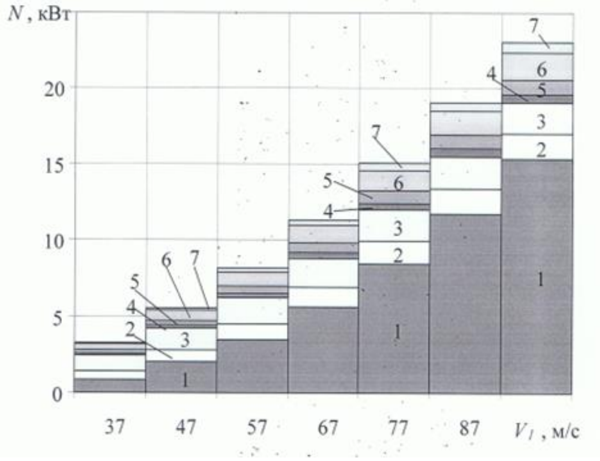

Fig. 2. A histogram showing the share of the components of the power balance equation from the total power N of the drive of the two-rotor shredder of branches at different speeds of movement V1 of the hammers (Q=1.58 kg/s): $1 - N_{xx};\ 2 = N_d^{nb};\ 3 = N_d^{n};\ 4 = N_{vp}^{nb};\ 5 = N_{\text{BO}}^{nb}; 6 = N_{\text{B}}^{n}; 7 = N_m.$

N - drive power kW, V1 vehicle speed, Q raw material supply, $N_{xx}, N_d^{nb}, N_d^{n}, N_{vp}^{nb}, N_{bo}^{nb}, N_{\text{B}}^{n}, N_m$ accordingly, the power required for: deformation of the branch when it is struck off-center with a hammer during unsupported wood grinding (at the first stage of grinding - at the entrance to the chamber and directly in it); deformation of the branch during support grinding of wood (at the second stage of grinding with the participation of counter hammers); throwing a branch (giving it translational speed) when it is struck off-center with a hammer during unsupported chopping of wood; throwing a branch (giving it a linear speed of rotation at the point of impact) when it is struck off-center with a hammer during unsupported wood chopping; discarding a branch during the support grinding of wood (at the second stage of grinding with the participation of counter hammers); overcoming the forces of friction of the particles of the circulating layer of wood against the loaded parts of the hammers during drawing and circulation of the mass between the surface of the grates and the hammers; idling of the shredder.

The machine developed by us is aggregated with Valtra G135 or Fendt 211 tractors. We know the necessary drive power of the unit for crushing brush (Fig. 2), the maximum value of which reaches 26 kW. So, let's calculate the hydraulic drive of the unit for crushing brush.

On the (Fig. 3) shows the basic hydraulic diagram of the drive of the rotors of the brush crushing unit.

Knowing the required power of the drive, we will choose the necessary hydraulic pump for driving the working bodies. The maximum power of the drive is 26 kW, the frequency of rotation of the pump shaft, n = 955 rpm; P nominal pressure in the hydraulic system, P=16 MPa. The hydraulic pump of the NSh type corresponds to these indicators, and the main functional dependencies of the selected hydraulic pump are given.

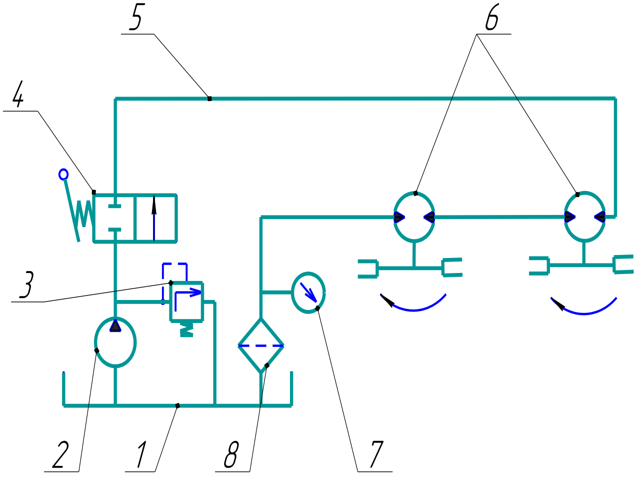

Fig. 3 Basic hydraulic scheme of the drive of the rotors of the brush crushing unit: 1 - hydraulic tank; 2 - hydraulic pump; 3 - safety valve; 4 - hydraulic distributor; 5 - hydroline; 6 - hydraulic motors; 7 - manometer; 8 - filter.

We will calculate the main parameters of the hydraulic pump. Let's determine the theoretical flow of the hydraulic pump.

$$Q_{\text{T}} = V_p \cdot \frac{n}{1000};\ \text{(r/min)}, \qquad (10)$$

V_p - working volume of the hydraulic pump, cm3 from (Fig. 1, a) it can be seen that at a shaft rotation frequency of 955 rpm. Vp=100 cm^3.

$$Q_{\text{T}} = 100 \cdot \frac{955}{1000} = 95{,}5\ \text{(r/min)}.$$

The actual supply of the hydraulic pump:

$$Q_f = V_p \cdot n \cdot \frac{\eta_V}{1000};\ \text{(r/min)}$$

η_V - volume Coefficient of useful effect of the pump, η_V = 0,96

$$Q_f = \frac{100 \cdot 955 \cdot 0{,}96}{1000} = 91{,}68\ \text{(r/min)}.$$

Volume Coefficient of useful effect of the pump η_V pump is the ratio of the actual supply to the theoretical $\eta_V = Q_{\text{ф}}/Q_{\text{т}}$;

η_M - mechanical efficiency is due to the loss of mechanical energy in the hydraulic machine, to overcome friction during the movement of the elements of the hydraulic machine through the liquid, friction in the liquid itself between its particles η_M = 0,98.

Overall efficiency:

$$\eta = \eta_V \cdot \eta_M, \qquad (11)$$

η=0,96·0,98=0,94

Let's determine the useful power of the pump Nk is the power provided by the pump to the working fluid

$$N_{\text{к}} = \frac{\Delta P \cdot Q_{\text{т}}}{61{,}2}, \qquad (12)$$

ΔP - pressure drop at the inlet and outlet of the hydraulic pump, MPa ΔP=15,8;

$$N_{\text{к}} = \frac{15{,}8 \cdot 95{,}5}{61{,}2} = 24{,}6\ kW$$

Pump power N is the power consumed by the pump:

$$N = \frac{\Delta P \cdot Q_{\text{ф}}}{61{,}2 \cdot \eta};\ \text{kW.}$$

$$N = \frac{15{,}8 \cdot 91{,}68}{61{,}2 \cdot 0{,}94} = 25.$$

Torque on the pump shaft:

$$\text{М} = 9554 \cdot \frac{N}{n}\ , \text{Н} \cdot \text{м}, \qquad (13)$$

$$\text{М} = 9554 \cdot \frac{25}{955} = 250, Nm$$

Determination of the main parameters of hydraulic motors.

As can be seen from fig. 3, our scheme provides for the serial connection of hydraulic motors for driving working bodies, to ensure the necessary power of the drive, we will choose rotary hydraulic motors of the OMR-125 type as hydraulic motors.

The torque on the hydraulic motor shaft is determined by the formula:

$$\text{М} = \frac{V_p \cdot \Delta P \cdot \eta_M}{2\pi}\ , \text{Н} \cdot \text{м}, \qquad (14)$$

$$\text{М} = \frac{125 \cdot 15{,}8 \cdot 0{,}98}{2 \cdot 3{,}14} = 312{,}1\ \text{Н} \cdot \text{м}$$

Conclusions. The use of wood waste as a source of heat energy can be considered the most promising direction in the development of alternative bioenergy. According to approximate forecasts, if all existing wood waste is processed and used as fuel, it is possible to obtain 2.4 billion kW of energy, which is equivalent to 300 million m3 of natural gas. Therefore, the formation of a clear structure of the processing and use of wood waste is an urgent and necessary task to increase the level of energy security of the state as a whole.

Other ways of using wood waste, in particular for mulching gardens, will reduce the loss of fertile soil by reducing erosion processes. Mulching will provide an opportunity to obtain organic products, will ensure a reduction in the use of chemical plant protection agents, and will also generally improve the environmental situation in agricultural production.

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ПЕРСПЕКТИВНІСТЬ І ОСОБЛИВОСТІ ТЕХНОЛОГІЙ УТИЛІЗАЦІЇ ГІЛОК У ІНТЕНСИВНИХ САДАХ І ПАРКАХ

Проведено дослідження технологій, які передбачають утилізацію гілок і мають широкий перелік технологічних операцій. Одна з найбільш поширених передбачає ручну обрізку при допомозі простих технічних засобів як гілкорізну бензопилу і акумуляторні пили. Зрізану деревину транспортують і накопичують в бурти, які при достатньому накопичуванні спалять. Дана технологія в першу чергу шкідлива в екологічному плані, так як забруднює навколишнє середовище. Тому властивість використання подрібнених гілок в якості мульчування міжрядь в садах і алеях парків є досить важливим фактором.

Дослідження застосування даної технології подрібнення гілок в щепу високотехнологічним агрегатом, дасть змогу зменшити витрати праці орієнтовно в 1,5 рази, палива в 1,4 рази, виключить забруднення навколишнього середовища, поповнити ґрунт органічними і мінеральними добавками та використовувати додаткові площі земельних угідь, які зараз відведені під площадки для спалювання деревини.

Технології, які передбачають утилізацію гілок після обрізування крони дерев, мають найрізноманітніші напрямки використання продукту обрізки та широкий перелік технологічних операцій. Кожна з них по-своєму цікава, має переваги та недоліки, і тому потребує більш детального висвітлення. Формування чіткої структури процесу переробки та використання відходів деревини є актуальним та необхідним завданням, для підвищення рівня енергетичної безпеки держави в цілому.

Ключові слова: *технологія, деревина, альтернативні джерела енергії, мульчування, сад, плодовий сад, хмиз, подрібнення, агрегат.*

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