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The method of calculating the parameters of the materials delivery mechanism of the technological materials distributor

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Abstract. In this article, road services use technological materials (sand-salt mixture) to remove snow, ice and ice from roads in the winter season. allows to reduce losses. The structural characteristics of technological material distributors are greatly influenced by working conditions and physical-mechanical properties of snow cover or ice. The technological material delivered to the spreading disc in a certain ratio (portion) should be connected with the speed of the machine, so the relationship between the speed parameters of the machine and the speed of the delivery mechanism was studied. A method has been developed to select the parameters of the spreading disc, which includes the change of the design parameters: disc diameter, disc height, disc angular velocity. When changing each parameter of the spreading disk, relationships were found that affect the range of the particle's flight distance.

1 Introduction

The main and most labor-intensive road maintenance works take place during the winter season. Winter maintenance difficulties are associated with the metamorphism of snow, its compaction, and then turning into snow-ice and ice, which creates a hazard for vehicles and pedestrians.

In different countries, road services use technological materials (sand-salt mixture) to remove winter snow, ice and ice. The use of technological materials makes it possible to clear the road surface of snow and ice in a relatively short time and reduce losses from speed and accidents [1].

Special machines are used for spraying technological materials. During the period of large-scale localization in the republic, the distributor of these technological materials was introduced to produce in Samarkand region as a result of the implementation of the truck production project of the German company "MAN".

At the session of the Cabinet of Ministers dedicated to the main results of 2012 and the priority directions of socio-economic development of Uzbekistan in 2013, the President of the Republic of Uzbekistan Islam Abdugyanevich Karimov said in his speech: "Germany's world-famous MAN in the automotive industry emphasized that the second stage of the

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creation of a new complex for the production of trucks with a production capacity of 3 thousand cars per year in the Samarkand region in cooperation with the company has been completed.

A high-tech production enterprise was created, equipped on the basis of high international standards, which produces the most modern heavy-duty vehicles, which not only meets the needs of our country, but also provides them for export"[2].

Nowadays, along with the increase in the number of people in the world, the number of vehicles is also increasing day by day, which in turn causes traffic jams on highways and becomes the main problem of vehicle traffic [3-12]. Road transport as an integral element of the country's national economic complex plays an important role in the implementation of the transport process [13, 14].

As a result, road services are provided with modern equipment for road maintenance and maintenance. In order to further increase the efficiency of the supplier and spraying of technological materials, it is necessary to carry out research aimed at justifying and choosing the parameters of mutual cooperation of the bodies performing this work.

2 Methodology

The structural characteristics of technological material distributors are greatly influenced by working conditions and physical-mechanical properties of snow cover or ice. There are flat and mountainous terrain conditions, which differ sharply in terms of snow accumulation, the ability of the vehicle to move, possible maneuvers and other factors.

Distributors are equipped with special equipment. special equipment was implemented taking into account the following basic requirements: standardization of dosing accuracy of a wide range of materials depending on the type of materials, weather conditions and the condition of the road surface; the constancy of the exhaust system, regardless of the speed of the car; uniform distribution of the material on the treated road surface, adjustment of the spreading width.

These requirements are also determined by technological tasks - to ensure the best quality of cleaning at the lowest economic cost - to reduce the harmful effects of anti-icing and other de-icing materials on the environment [11].

The special equipment of the distributors itself consists of an all-metal construction with bent side walls, welded (welded) in the shape of a bunker. It is mounted on a subframe mounted on parts of the main vehicle chassis. In order to prevent large stones, frozen mud or sand from entering during loading, a grid of metal rods is installed at the top of the hopper.

The distribution mechanism is located at the bottom of the bunker. For dividing the part coming from the process material supply mechanism from the back of the hopper, the hopper (parts), the drive reducer of the supply mechanism and the sprinkler disk itself (Figure 1) are presented.

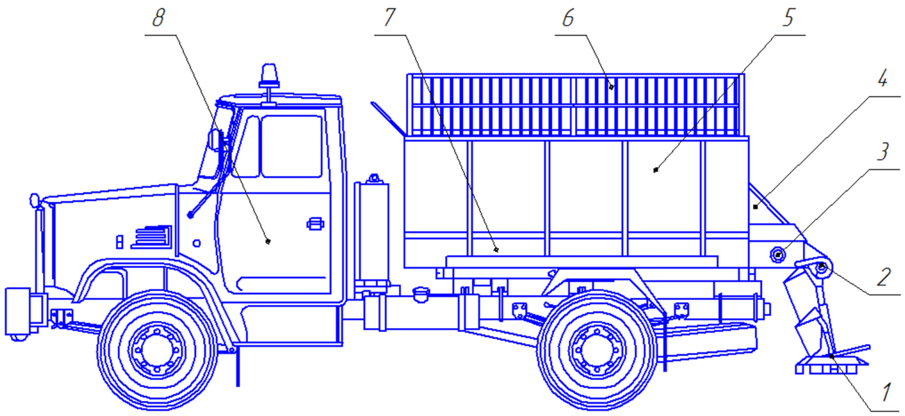

Fig. 1. Distributor of technological materials: 1-sowing (distributing) disc; 2- disk reducer; 3-delivery mechanism reducer of the feeding mechanism; 4- roof barrier; 5th bunker; 6 - fence; 7-delivery mechanism; 8 - the main machine.

Technological materials are spread out from the center of the disc, rotating at a certain angular speed along the ribs, overcome the resistance on the surface of the disc under the influence of centrifugal forces, move to the outer edge and reach a certain distance and fall on the surface of the carriageway. In different machines, disc diameters can vary from 0.60 to 0.70 meters, and the rotation speed can vary from 200 to 600 rpm [13-20].

The amount of seeding is regulated by changing the speed of the conveyor delivery mechanism, the frequency of rotation of the seeding disk and the adjustment of the hopper flood.

To calculate the positions of the parameters of the mechanism, we take the most commonly used scraper conveyor. According to its working principle, this conveyor is similar to a belt conveyor, its construction includes a hook and a lift to move the technological material.

When calculating this mechanism, we consider its main structural parameters (Figure 2). A scraper conveyor located at the bottom of the hopper carries the technological material with scrapers and transfers it to the spreading disc. Dosing of the technological material entering the spreader disc occurs due to the speed of the conveyor and the large opening of the cover door. Thus, depending on the opening of the cover door, the volume of distributed technological material increases or decreases (Figure 2).

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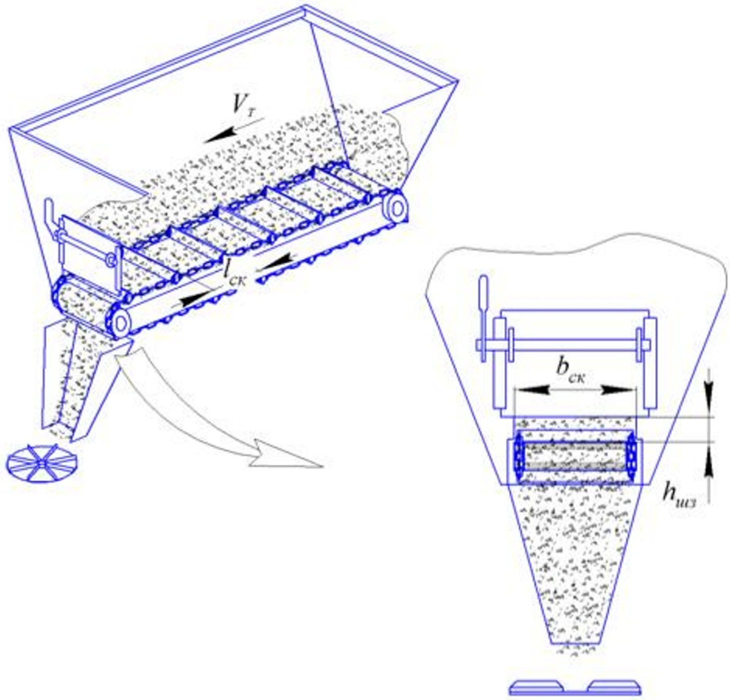


Fig. 2. Structural parameters of the scraper conveyor: V_{TM} – the speed of the technological material delivery mechanism; $b_{q.k}$ - the width of the scraper; $h_{q.e_{och}}$ – flap door opening height; $l_{q.o.m}$ - the distance between the scrapers.

3 Results

The technological material delivered to the spreading disk in a certain proportion (portion) must be connected with the speed of the machine, therefore, the relationship between the parameters of the machine speed and the speed of the delivery mechanism is necessary.

Step by step, we find the interdependence of relations using the following formulas.

Thus, to find the amount (portion) of the technological material that can be delivered by the delivery mechanism, we find the density ρ of the technological material in the spread.

$$\rho = \frac{m_{t.m}}{S_{s,m}}; \text{ kg} \quad (1)$$

Here: $m_{t.m} -$ mass of technological material, kg;
$S_{s,m} -$ material spraying area.

$$S_{s,m} = S_L \cdot S_{s.k}\ ;\ m^2\ ; \quad (2)$$

Here: $S_L -$ the distance traveled by the car, m;
$S_{s.k} -$ material spreading width, m, in turn

$$S_L = V_{м} \cdot t \quad (3)$$

Here: $V_{м} -$ the speed of the car, m/sek;

t –time, sek.

Mass of technological material m_{tm} is equal to:

$$m_{tm} = \frac{V_{TM} \cdot t}{l_{q.o.m}} \cdot m_{q.o.tm} \text{ ; kg,} \tag{4}$$

Here: V_{TM} – the speed of the delivery mechanism, m/sek;

t –time, sek;

$m_{q.o.tm}$ - the mass of technological material in the space between the scrapers, kg;

$l_{q.o.m}$ - the distance between the scrapers, m.

The mass of the technological material in the space between can be found from the formula $m_{q.o.tm}$

$$m_{q.o.tm} = b_{q.k} \cdot h_{q.e_{och}} \cdot l_{q.o.m} \cdot \rho_{tm} \text{ ; } kg. \tag{5}$$

Here: $b_{q.k}$ - the width of the scraper, m;

$h_{q.e_{och}}$ - flap door opening height, m;

$l_{q.o.m}$ – the distance between scrapers, m;

ρ_{tm} - 1,6 m³ mass of technological material,

After changing to take into account the above equations, equation 1 looks like this:

$$m_{tm} = \rho \cdot V_{м} \cdot t \cdot S_{s.k} \text{ ; kg} \tag{6}$$

Now we take the right-hand sides of equations 4 and 6 and convert:

$$\rho \cdot V_{м} \cdot t \cdot S_{s.k} = \frac{m_{q.o.tm}}{l_{q.o.m}} \cdot V_{TM} \cdot t \tag{7}$$

In the calculation above, the value of the parameters of the spreader disc is determined and it depends on the following parameters $S_{ш}$:

$$S_{s.k} = f\left(\omega_{д}; \emptyset_{д}; H_{д}\right) \tag{8}$$

The diameter of the spreading disk $\emptyset_{д}$, angular velocity of the spreader disc $\omega_{д}$ and the height of the sprinkler disc $H_{д}$ based on the selected values of $S_{s.k}$ can be determined.

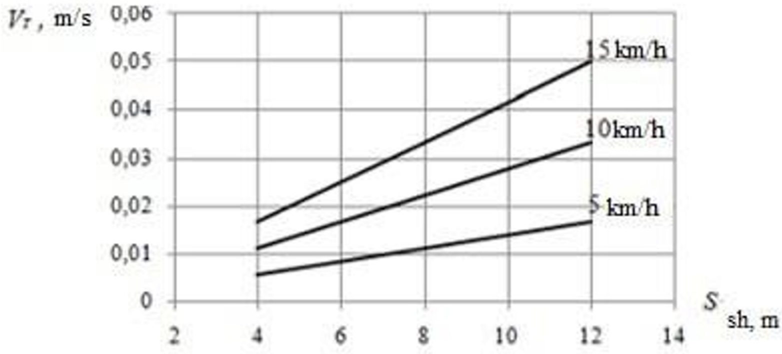
Then, those known in equation 7 ρ; $S_{s.k}$; $m_{q.o.tm}$; $l_{q.o.m}$.

Based on the given data, we get the value V_{TM}

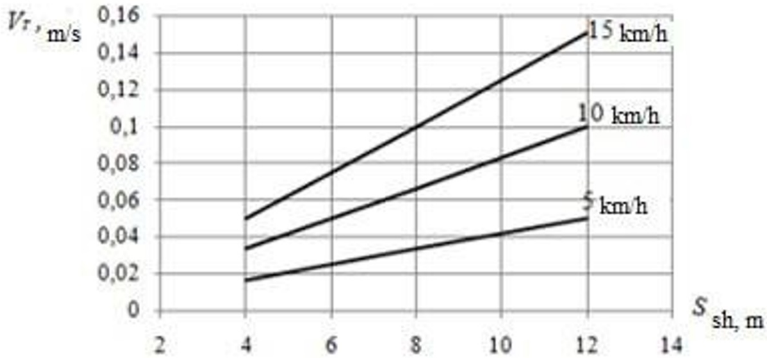
$$V_{TM} = \frac{\rho \cdot V_{м} \cdot S_{s.k} \cdot l_{q.o.m}}{m_{q.o.tm}} \text{ ; m/sek} \tag{9}$$

From here we can build a dependency

$$V_{TM} = \frac{\rho \cdot S_{s.k} \cdot l_{q.o.m}}{m_{q.o.tm}} \text{ ; m/sek} \tag{10}$$


V_T, m/s
0,06
0,05
0,04
0,03
0,02
0,01
0
15 km/h
10km/h
5 km/h
2
4
6
8
10
12
14
S sh, m

a)


V_T, m/s
0,16
0,14
0,12
0,1
0,08
0,06
0,04
0,02
0
15 km/h
10 km/h
5 km/h
2
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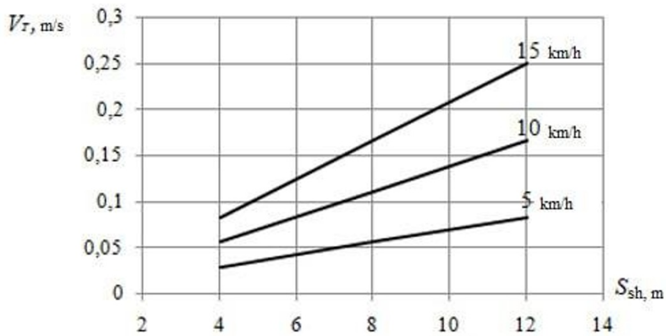
14
S sh, m

b)


V_T, m/s
0,3
0,25
0,2
0,15
0,1
0,05
0
15 km/h
10 km/h
5 km/h
2
4
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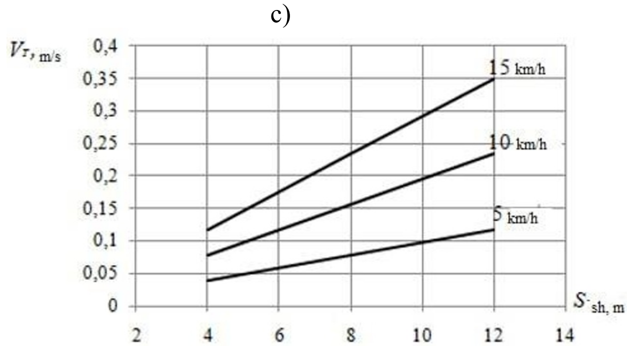
14
Ssh, m

c)


V_T, m/s
0,4
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
15 km/h
10 km/h
5 km/h
2
4
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8
10
12
14
S sh, m

d)

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Fig. 3. . In the graph: (a) for ρ=50; (b) ρ =150; (v) ρ =250; (g) ρ = 350; quantity in kg, technological m_ in scrapers $m_{q.o.tm}$ the mass of the material is. Delivery mechanism V_{TM} speed and machine $V_{м}$ speed, sprinkling $S_{s.k}$ depends on the width being sprinkled at different ρ densities.

The total value can be entered as the coefficient of proportionality (a) of the speed, taking into account the formula 10 (Figure 3).

$$a = \frac{\rho \cdot S_{s.k} \cdot l_{q.o.m}}{m_{q.o.tm}} \tag{11}$$

Then 10 formulas will be in the following form.

$$V_{TM} = a \cdot V_{м}; \;\; \text{m/sek} \tag{12}$$

In the distribution of technological material, it has a similar cycle of operation, which differs only in the absolute value of individual modes and parameters, because they work at different speeds and rates when sprinkling technological materials, which has a decisive effect on productivity.

When calculating productivity, the technological mixture in the fall, the density of the material, and the amount of technological material sprayed in one minute of work are taken into account for the main data (Figure 4).

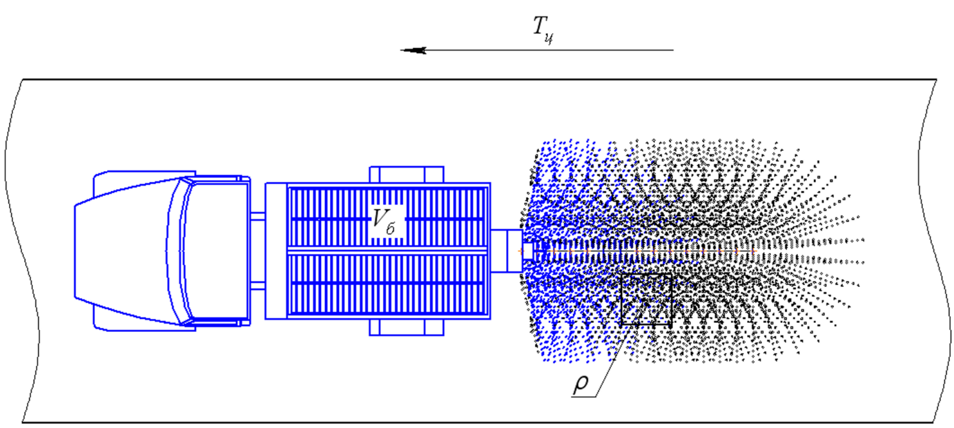

Fig. 4. Sowing performance indicators: V_b – hopper volume; ρ - sprinkling density; T_{ts} - duration of the work cycle.

Based on these indicators, the sprinkling productivity U in m²/hour operation is determined [9].

$$U = \frac{60 \cdot V_б}{T_{ts} \cdot \rho} \tag{13}$$

bu erda $V_б$ - the size of the bunker, kg

ρ – sprinkling density, kg/m²;

T_{ts} - duration of one working cycle of the machine, in minutes.

This value of the full cycle of the duration of spraying work cycle T_{ts} includes the time from the place of spraying process materials to the warehouse and back, including the time of maneuvering during loading, the loading itself and the duration of loading, and the final stage during one-time spraying.

$$T_{ts} = t_{b.s} + t_{y,u,k} + t_{e.b} \quad (14)$$

Here: $t_{b.s}$ – time taken for one spraying, in minutes;

$t_{y,u,k}$ - the time taken to load the material in the warehouse into the hopper of the machine, in minutes;

$t_{e.b}$ – arrival time, in minutes.

In turn, the duration of a single spraying $t_{b.s}$ depends on the speed of movement and the nature of spraying and the width of spraying technological materials.

$$t_{b.s} = \frac{V_6 \cdot К_{s.h}}{60 \cdot \rho \cdot S_{s.k} \cdot V_М} \quad (15)$$

Here: $К_{s.h}$ - the coefficient describing the uniformity of the spraying action during the operation of the cycle $К_{s.h}$ = 1,0-1,2;

$S_{s.k}$ – width of sprinkling on the road surface m;

The duration of loading the material in the warehouse into the hopper of the machine t_{yuk} depends on the volume of loading of the technological material into the hopper V_6.

$$t_{yuk} = V_6 \cdot t'_{yuk} \quad (16)$$

Here: t'_{yuk} - The time of washing 1 ton of technological material into the warehouse, per minute.

When determining productivity, it is necessary to take into account the norm of the maximum limit of the specified sprinkling density ρ of 350 g/m^2.

To determine the productivity from the above calculated data, we draw graphs of the hopper capacity V_6 and the productivity U of sprinkling at different speeds, as well as the dependence of ρ on the sprinkling density of the technological material (Figures 5 and 6).

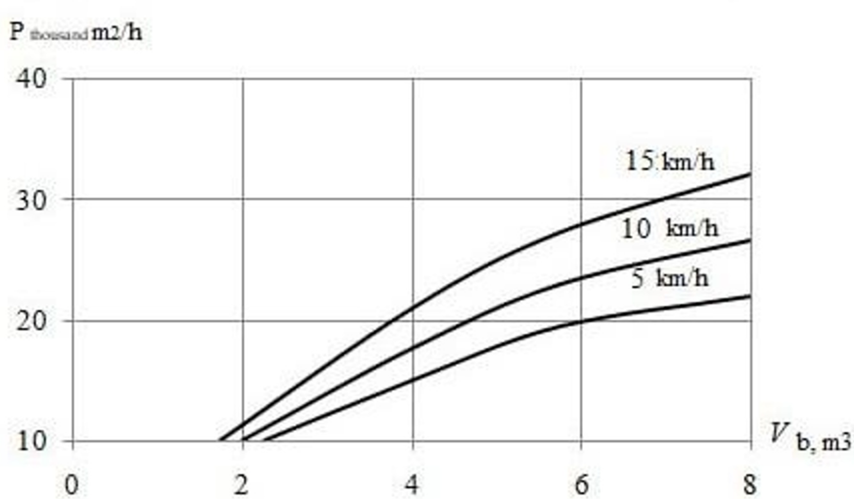

Fig. 5. Dependence of spraying U productivity on hopper capacity V_6.

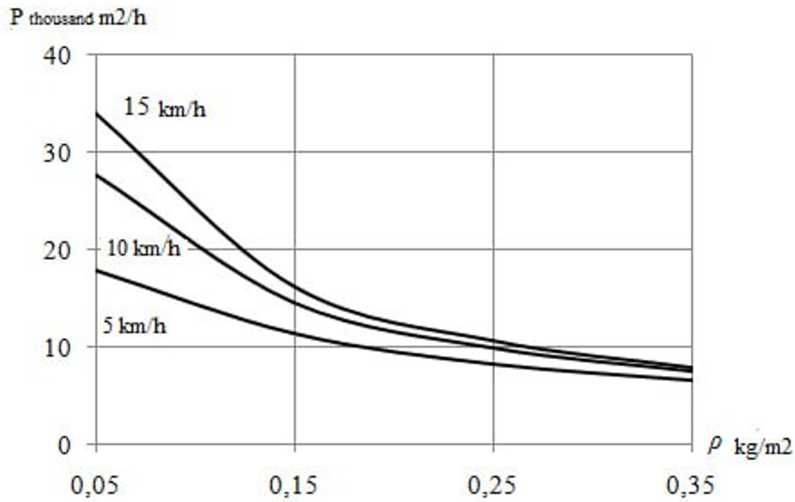

Fig. 6. Dependence of sprinkling productivity U on ρ sprinkling density of technological material.

4 Conclusion

A method has been developed to select the parameters of the spreading disc, which includes the change of the design parameters: disc diameter, disc height, disc angular velocity. When changing each parameter of the spreading disk, relationships were found that affect the range of the particle's flight distance. Thus, with the minimum value of one of the considered parameters, the flight distance of the particle is 1.5 meters or more, and with the maximum value, the flight distance of the particle is more than 6 meters. Based on this, we can say that the minimum and maximum spreading width is more than 3 to 12 meters. When considering the design of the scraper conveyor, its main parameters are selected: the width of the scraper; door opening height; distances between scrapers. The methods of selecting material delivery in the considered parameters showed that the delivery speed depends on the design parameters that change the speed proportionality coefficient (a) and the speed of the main machine. Thus, the speed of the delivery mechanism when spraying 1 kilogram of technological material is from 0.005 m/sec to 0.35 m/sec. The variation in this delivery rate will depend on the spread width of the material, the spread density and the speed of the main machine.

The efficiency of the spreader of technological materials was determined depending on: the amount of technological material in the hopper; technological material sprinkling density and continuity of work cycle. Thus, the productivity of the spreader of technological material with a hopper volume of up to 8 m^3 and the speed of the machine from 5 km / h to 15 km / h averages from 22 to 33 thousand m^2 / h, and the productivity depends on the density of spraying and the speed of the machine it turned out that the speed from 5 km / h to 15 km / h is from 18 to 34 thousand m^2 / h.

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