Parameters of the airflow when exiting the fan

Muxtor Xalilov*, and *Khayriddin* Fayzullaev

Karshi engineering-economics institute, 225, Mustakillik str., Karshi, 180100, Uzbekistan

Abstract. The purpose study is to substantiate the parameters of the air flow when exiting the casing and the working parts fan. In the course of studies, the pressure and air flow velocity were determined by an improved Pitot-Prandtal tube. In experimental studies, the influence speed fan wheel improved sprayer on the parameters air flow when exiting the window casing and the working part was studied. It was found that the pressure air flow from the window fan casing increases on average from 65 Pa to 152 Pa when the number of revolutions wheel is increased from 800 r/min to 1200 r/min, and 5.5 times when the number of revolutions is increased from 800 r/min to 1600 r/min. The speed air flow coming out window shroud fan depends on the pressure, it was observed that the speed increased by 2.5 times when the pressure in the system increased from 100 to 350 Pa. According to the results studies carried out, in order to ensure high-quality chemical processing with low energy consumption, the number of revolutions centrifugal fan wheel should be equal to 1500 r/min.

1 Introduction

Sprayers currently used in the agricultural production republic have a number of significant drawbacks. In particular, they do not provide treatment with chemical preparations throughout the profile, unevenly distribute the chemical preparation over the treated surface, have a high degree of working fluid consumption, damage plants to a small extent, have a high material and energy intensity. This leads to a deterioration in the quality chemical processing vineyards and orchards, a decrease in labor productivity and an increase in fuel costs and other expenses. Based on this, the ongoing research is aimed at improving the quality of work and productivity unit during chemical processing of vineyards and orchards reducing energy intensity by improving the existing sprayer in technical and technological aspects. According to the parameters of the air flow coming out of the window and the working part of the spray fan F Maiviatov [1, 2, 7], K Fayzullaev [3, 5], F. Mamatov [3, 4], K Ravshanov [2, 5], O. Hamroyev [6], B Mirzaev [4, 8], D Djuraev [9], M Khalilov [10] conducted research.

The purpose study is to substantiate the parameters air flow when exiting the casing and the working parts fan.

* Corresponding author: xmuxtor83@mail.ru

2 Materials and methods

The aerodynamic performance air flow coming out working parts on which the centrifugal fan casing is installed directly affects the quality of spraying the working fluid. Therefore, it is necessary to theoretically determine the pressure air flow generated by the fan at the exit from the working part of the sprayer and its lost part, speed and performance.

The input and output jacks working parts were made in a rectangular shape, and the shape output window was prepared by changing in relation to the input window (Figure 1).

The surface outlet window S_2 the surface of the inlet window S_1 ganisbatan is made small, the distance between them is equal to L.

In this case, the air flow formed by the fan spreads out from the outlet window working part and provides comprehensive processing to trees up to 3. 0 - 3. 5 meters high. Similarly the working parts are prepared to be replaceable and are mounted and machined in a sprayer based on the dimensions gardens to be treated [2].

In this case, the air flow formed by the fan spreads out from the outlet window working part and provides comprehensive processing to trees up to 3. 0-3. 5 meters high.

Similarly, the working parts are made interchangeable and are mounted on the sprayer and treated based on the dimensions gardens to be treated [2].

The main task here is to determine the actual values of pressure, speed and performance air flow coming out windows and working parts sprayer during the operation suspended spray fan.

In the process of work, the suspension sprayer was installed on the MTZ - 80. 1 tractor. The working parts for processing fruit and non-fruit orchards were installed on the two side air exit windows suspension sprayer fan box. With these working parts, vineyards planted in rows up to 3 meters high, apples, pomegranates, figs and other orchards are chemically treated.

3 Results and discussion

The tests were carried out with the following parameters suspended spray fan: the diameter fan wheel is 630 mm, the length blades installed on it is 140 mm, its width is reduced on one side - 150 x 200 mm, the diameter air flow inlet box is 340 mm and the gap between the wheel and the air outlet window cabin in the direction of its rotation is equal to 100 mm.

Experiments to determine the pressure and speed air flow coming out two side windows spray fan housing were performed as follows:

- the spray fan wheel was adjusted to the required number of revolutions using a tachometer tool;
- each side window box was divided into sections consisting of a right-angled rectangle, i.e. each side was rounded, creating 16 small quadrilaterals and the procedure for testing them numbered by;
- air flow parameters from the center of each small four corners were determined with a developed tube connected to the MMN-2400 (5)-1. 0 micromanometer and data were obtained.
- n = 800 r/min sprayer fan wheel in the order given above; 1000 rpm; 1200 rpm; 1400 rpm; 1600 rpm; The parameters air flow coming out window cabin at the number of revolutions of 1800 r/min were determined.

To carry out experiments at a high level, it is necessary to ensure that the MMN-2400 (5) – 1. 0 micromanometer tube is perpendicular (vertical) to the plane of each test point and does not move during the experiment.

A special device was required to obtain high-precision values pressure and velocity of the airflow generated by the fan in the Pitot-Prandtal tube. The main task of the special device

 https://doi.org/10.1051/e3sconf/202339004037

is to ensure that the tube is fixed vertically and immovably at the desired point when determining the parameters air flow. Since such a special device did not exist, it was required to design and develop it. In the development of a special device, the adjustment tube in the horizontal and vertical planes was assumed as the main factor.

A special device was developed in the form of a vertical tripod based on the above requirements (Figure 2). Determination of air flow pressure and speed on the surface outlet windows working part of the sprayer for its left and right sides was carried out as follows: the air flow outlet surface working part contour was divided into 5 small rectangles and their centers were marked from points (1, 2, etc.) tests were conducted to determine the pressure and speed of the air flow at each number of rotations fan wheel in the above-mentioned manner.

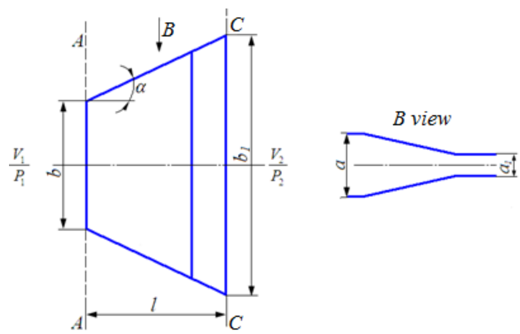

Fig. 1. Scheme working part universal suspension sprayer: A-A working part entry window; V-V working part exit window.

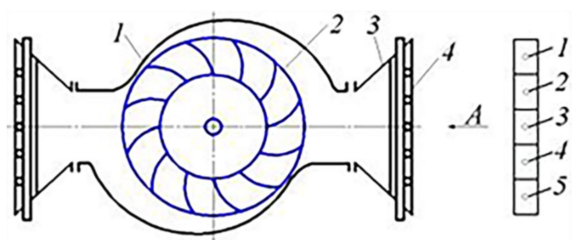

Fig. 2. Technological process drawing working part installed in the windows spray fan: 1 – casing; 2 – fan wheel; 3 – working part; 4 - air outlet windows.

During the tests, the relative humidity and temperature air stream was determined on the MV – 4 M psychrometer based on the requirements given in its manual. During the tests, the natural speed air flow was determined by the MI -13 anemometer at heights of 0. 5 and 2. 0 meters above the ground level. When conducting scientific research tests, it was assumed that the pressure air flow coming out small rectangular surfaces is equal on its surfaces, and calculations were taken from their centers.

The data obtained in the conducted studies were processed in a computer program based on mathematical statistics, and their average values, mean square deviation and coefficients of variation were determined. Connection graphs were built based on the average values determined air flow parameters [3, 7].

Figure 4 shows graphs dependence pressure air flow coming out right and left windows fan box on the number of revolutions of the wheel.

When analyzing the connection graphs made as a result research, it was observed that with the increase in the number of revolutions fan wheel, the pressure air stream also increases. For example: when the number of revolutions fan wheel is increased from 800 r / min to 1200 r / min, the air flow pressure increased from 65 Pa to 152 Pa on average, that is, when the number of revolutions increased by 1. 5 times, the pressure increased by 2. 3 times was determined. When the number of revolutions is increased by 2 times, i.e. from 800 r / min to 1600 r / min, the pressure is equal to 358. 5 Pa, and it is found that it increases 5. 5 times. It was found that the pressure increases more rapidly in relation to the increase in the number of revolutions. The relationship between the number of revolutions and the pressure is linear, and its equation, for the left and right sides, was determined on the basis of a computer program. Using the defined equations, the number of rotations fan wheel was limited, that is, 700 n 2000 r/min. Therefore, the following equations were obtained for the values wheel revolutions in the range of 700 n 2000r/min when determining the air flow pressure, speed and performance:

– for the right side $P_{\text{right}} = 0{,}00008n^2 + 0{,}0989\ n - 68{,}885$; $R^2 = 0{,}9976$;
– for the left side $P_{\text{left}} = 0{,}0001n^2 - 0{,}0412n + 10{,}926$; $R^2 = 0{,}9945$.

In order to simplify calculations in further studies, the following equation was obtained to determine the average pressure based on the above equations

$$P_{ave} = 0{,}0001n^2 + 0{,}0292n - 29{,}204. \quad (1)$$

Using this expression, the actual value pressure air flow coming out windows fan box is determined depending on the number of revolutions wheel. When analyzing the graph dependence speed air flow coming out right and left windows fan box on the number of revolutions wheel, the following was determined (Figure 3). When the number of revolutions wheel is increased from 800 r / min to 1200 r / min, the air flow speed increased from 10. 65 m / s to 16. 2 m / s on average, that is, when the number of revolutions is increased by 1. 5 times, the speed is similar, that is, 1. 52 times increased.

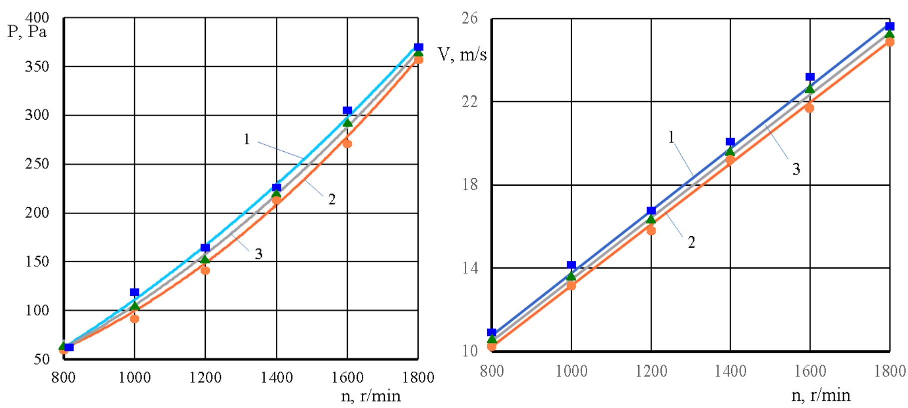

Fig. 3. The graph of the dependence of the pressure and speed of the air flow coming out of the windows of the spray fan box on the number of revolutions of the wheel *n:* 1- right side; 2 – left side; 3 is average; 1-for the exit window of the right side of the cabin; 2-for the exit window of the left side of the cabin; 3-average.

When the number of revolutions is increased by 2 times, that is, from 800 r/min to 1600 r/min, the speed is equal to 25. 1 m/s, which increases by 2. 3 times, while the air pressure increases by 5. 5 times. Therefore, the speed air flow coming out window increases several times less than the pressure, depending on the number of revolutions wheel. The speed air flow coming out windows of casing depends on the number of revolutions fan wheel in a straight line, and its relation equation for the left and right sides has the following form:

– For the right side $V_{right} = 0{,}015\ \text{n} - 1{,}2795$, m/s; $R^2 = 0{,}9972$;
– For the left side $V_{left} = 0{,}0147n - 1{,}542$, m/s; $R^2 = 0{,}997$.

To simplify calculations, we determine the average air speed based on the above equations

$$V_{ave} = 0{,}0149n\text{- }1{,}4107,\text{ м/с; } R^2 = 0{,}9944. \quad (2)$$

Using the given expression (2), the actual value speed air flow coming out windows fan box is determined depending on the number of revolutions wheel.

The output sprayer working part graphs of dependence built on the basis results research on determining the dependence air flow pressure coming out window surface on the number of revolutions fan wheel are presented in Figure 3.

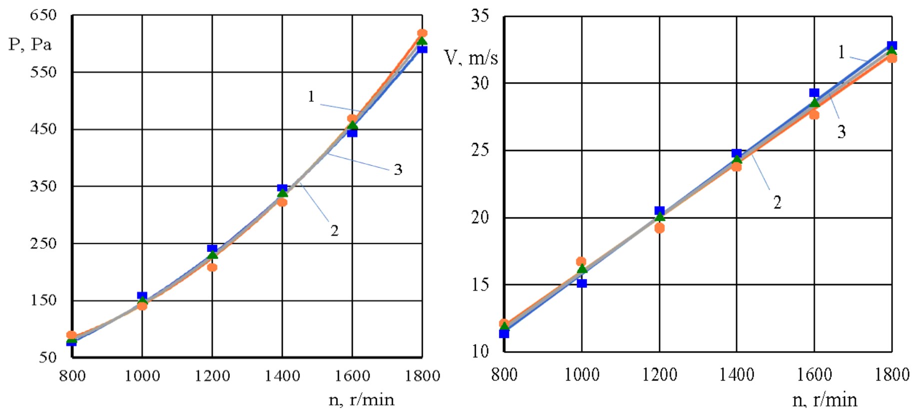

Fig. 4. Graph of the pressure and speed air flow coming out working part sprayer as a function number of revolutions wheel *n*.

Figure 6 shows the correlation graphs based on the results study on determining the dependence air flow pressure coming from the surface outlet window sprayer on the number of revolutions fan wheel.

As can be seen from Figure 4, when the number of revolutions fan wheel is increased, the pressure air flow coming out surface outlet window sprayer working part in general increases. When the number of revolutions fan wheel is 1000 r/min, the pressure air stream coming out surface outlet window sprayer working part is equal to 100 Pa, and when the number of revolutions wheel is increased to 1800 r/min, it is equal to 580 Pa. In this case, when the number of revolutions wheel is increased by 2 times, the pressure air flow increases by 5. 8 times. It was found from the graph that the dependence of the pressure air flow coming out working part on the number of revolutions fan wheel is in the form of a curved concave line, which is expressed as follows:

– For the right side V_{right}=0,0002n^2 – 0,0674n - 11,136;
– For the left side V_{left}=0,0003 n^2 - 0,2592 n + 98,317.

As you can see from the connection graphs, the difference between their values is small, so for future use, we determine the average based on the above equations

$$P_{ave} = 0{,}0003\, n^2 - 0{,}1633n + 43{,}59. \quad (3)$$

When analyzing the graph dependence speed air flow from the surface outlet window sprayer (right and left sides) on the number of revolutions fan wheel (Figure 4), the following was determined. When the number of revolutions wheel increased from 800 r / min to 1200 r / min, the average speed of air flow increased from 11. 86 m / s to 20. 43 m / s. That is, when the number of revolutions is increased by 1. 5 times, the speed increases by 1.72 times. When the number of rotations is increased from 800 r/min to 1600 r/min, i.e. by 2 times, the speed of the air flow is 27. 15 m/s, which is increased by 2. 3 times, while the increase in the air flow pressure is 5. 8 times increased. Thus, it was found from the experiments that the speed air flow (right and left sides) increases several times less than the pressure, and its connection equation for the left and right sides has the following form

– For the right side V_{right}= 0,0213 n - 5,5109, m/s; R^2 = 0,9923;
– For the left side V_{left}= 0,0202 n – 4,1881, m/s; R^2 = 0,9946.

In order to simplify the calculations, we get the following equation for the average speed based on the above equations

$$V_{ave} = 0{,}0208\, n - 4{,}8495,\ \text{m/s}. \quad (4)$$

Figure 5 presents the results experiments conducted to determine the dependence air flow consumption (right and left sides) on the surface outlet window sprayer working part, depending on the number of revolutions fan wheel.

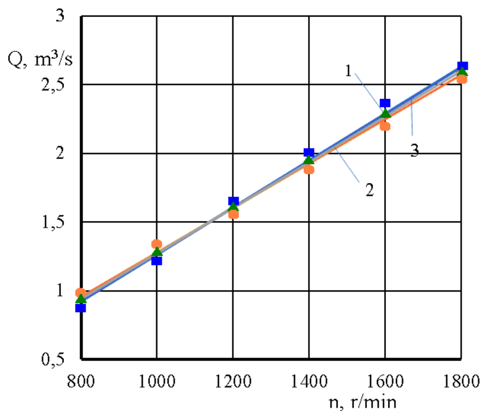

Fig. 5. The graph dependence air flow consumption from the surface outlet window sprayer working part (right and left sides) on the number of revolutions fan wheel: 1-right side; 2-left side; 3-average.

Based on them, with the increase in the number of revolutions fan wheel, the consumption air flow from the surface working part also increases.

For example, when the number of revolutions wheel increased from 800 r / min to 1200 r / min, the consumption air flow from the surface outlet window sprayer working part increased from 1. 63m^3 / s to 2. 78 m^3 / s on average. That is, when the number of rotations is increased by 1.5 times, the consumption of air flow increases by 1. 70 times.

When the number of revolutions is increased from 800 r/min to 1600 r/min, the average air flow consumption is 1. 63 m^3 / s to 3. 7 m^3 / s, and it has increased by 2. 3 times.

The dependence air flow consumption from the surface of the working part sprayer on the number of revolutions fan wheel is in the form of a straight line, and it is expressed as follows:

– For the right side Q_{right}= 0,0213 n –5,5109m^3/s; R^2 = 0,9923;
– For the left side Q_{left} = 0,0210n- 5,183m^3/s; R^2 = 0,9915.

Since the values above expressions are very close to each other, we determine their average for use in further calculations

$$Q_{ave} = 0{,}0208\, n - 4{,}8552\ \text{m}^3/\text{s}\ . \quad (5)$$

4 Conclusions

The pressure air flow coming out window fan box increases from 65 Pa to 152 Pa on average when the number of revolutions wheel increases from 800 r/min to 1200 r/min and 5.5 when the number of revolutions increases from 800 r/min to 1600 r/min times increase was found. The speed air flow coming out window fan box depends on the pressure, and it was observed that the speed increased by 2.5 times when the pressure in the system increased from 100 to 350 Pa. According to the results research, the number of rotations centrifugal fan wheel

https://doi.org/10.1051/e3sconf/202339004037

should be equal to 1500 r/min in order to ensure high-quality chemical treatment with low energy consumption.

References

1. F. Maiviatov, F. Karshiev, Sh. Gapparov, IOP Conf. Series: Earth and Environmental Science **868**, 012060 (2021)
2. F. Maiviatov, K. Ravshanov, S. Mamatov et al, IOP Conf. Series: Earth and Environmental Science **868**, 012066 (2021)
3. K. Fayzullaev, E. Mamatov et al, E3S Web of Conferences **304**, 03012 (2021)
4. F. Mamatov et al, Journal of Physics: Conference Series **1779**, 012002 (2021)
5. K. Ravshanov, K. Fayzullaev et al, IOP Conf. Series: Materials Science and Engineering **883**, 012138 (2020)
6. O. Hamroyev et al, E3S Web of Conferences **264**, 04052 (2021)
7. A. Maiviatov, A. Karshiev, Sh. Gapparov, IOP Conf. Series: Earth and Environmental Science **868**, 012060 (2021)
8. B. S. Mirzaev, G. H. Ergashov, F. M. Maiviatov, N. B. Ravshanova, S. J. Toshtemirov, M. F. Begimkulova, IOP Conf. Series: Earth and Environmental Science **1076**, 012022 (2022)
9. D. Djuraev, M. Khalilov, S. Badalov, M. Nurmonova, International Journal of Scientific & Technology Research **9(2)**, 3797-3800 (2020)
10. M. Khalilov, R. Yusupov, E3S Web of Conferences **264**, 04041 (2021)