

JUSTIFICATION OF THE OUTER DIAMETER OF THE FAN WHEEL OF THE
SPRAYER

D. Djuraev, I. Zh. Toirov — Associate Professors of KSTU

Sh. F. Zhuraev — Master's Degree Holder of KSTU

Annotation. The articles provide a review analysis of theoretical and practical research conducted by scientists on the justification of the impeller diameter of a spraying fan. As a result of the analysis, it was found that, taking into account the application area of the designed fan, the researchers proposed solutions to the issue under consideration and presented conclusions regarding the justification of the fan impeller diameter.

Keywords. Fan, outer diameter, rotational speed, airflow, wheel, centrifugal, blade, static pressure

Introduction. The diameter of the fan impeller (D) is one of the key parameters of a fan. Below is a review and analysis of scientific studies conducted by our researchers on the theoretical and practical determination of the fan impeller diameter.

In Nevelson M.I. [1; p. 52], when determining the fan wheel diameter D , the circumferential velocity of the wheel V_2 was first determined based on the specified air flow pressure. Then, using the circumferential velocity V_2 and the rotational speed, the wheel diameter D was calculated and adopted using the following expression.

$$D = \frac{60 \cdot V_2}{r \cdot n} \quad (1)$$

The actual value of the rotational speed V_2 was determined based on the diameter D of the driven wheel using the following expression..

$$V_2 D = \frac{r \cdot D \cdot n}{60} \quad (2)$$

Kalinushkin M.P. [2; p. 181], when determining the wheel diameter D based on the speed coefficient, proposed the following equation (3):

$$D = D_o \frac{60}{n_y} \quad (3)$$

This expression can be applied under the following conditions: when the fan speed ratio $p_u = 20 \dots 55$, the blade width of the fan wheel is uniform e., $b = b_l$, the air outlet angle from the blade surface $\beta_2 < 90^\circ$, and when the blade is inclined forward in the direction of rotation.

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$b = b_l$, the air outlet angle from the blade surface $\beta_2 > 90^\circ$, and when the blade is inclined forward in the direction of rotation.

The above expression and the conditions applied to it cannot be applied to all

Cherkassky V.M. [3; pp. 153–155] in 1968 determined the diameter of the fan wheel using the method proposed by Nevelson M.I. [1; p. 52].

Turbine B.G. [4; pp. 35–39] proposed a completely different, new method for the theoretical determination of centrifugal fan parameters. According to this method, the diameter of the fan's impeller D is chosen without performing calculations. Based on the selected impeller diameter D , all other fan parameters are determined as certain percentages of it. The impeller diameter D chosen by him does not comply with the standard GOST 10616-2015, however, such fans operate well in production.

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Sherstyuk A.N. [5; P. 26-28] (1972) based on theoretical and practical research on centrifugal fans came to the following conclusion: one of the main parameters of the fan wheel is the ratio of the diameters of the air flow entering and leaving the wheel, and he gave it as follows (4):

Sherstyuk A.N. [5; pp. 26-28] (1972), based on theoretical and practical studies of centrifugal fans, came to the following conclusion: one of the main parameters of the fan impeller is the ratio of the diameters at the air inlet and outlet of the impeller, which he presented as follows (4):

$$m = \frac{D}{D_o} \quad (4)$$

He concluded that an increase in this ratio would lead to an increase in the static pressure fraction of the air flow due to the centrifugal force acting on the air stream during the transfer motion.

With an increase in this ratio in the airflow in motion, under the influence of centrifugal force, the proportion of static pressure increases.

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Ivanov O.P. [6; p. 182] derived the following equation (5) for determining the optimal diameter of the fan wheel, taking into account the inlet flow angle β_1 to the blades

$$D_0 = 1,723 \sqrt{\frac{Q}{\omega \sin 2\beta_1}} \quad (5)$$

Ivanov O. P. [6; p. 182] also presented the SAGI method for determining the optimal wheel diameter according to equation (3.12) (6).

$$D_0 = k3Q \omega \quad (6)$$

Results. The above presents an overview analysis of the theoretical and practical research conducted by scientists on the justification of the fan diameter. The analysis showed that researchers approached the justification of the fan diameter based on their respective fields, that is, they proceeded from the intended application area of the designed fan and determined the solution to the problem accordingly. Based on the above analyses and conducted theoretical and practical studies, the following conclusions can be drawn regarding the justification of the fan diameter:

- It is recommended to determine the diameter of the fan wheel depending on the diameter of its air intake port.;
- It is recommended to determine the fan diameter based on the diameter of its air intake opening;
- Sherstyuk A.N., when justifying the fan diameter, presented the relationship between the impeller diameter and the diameter of the air inlet window in the form of the ratio $D/D_o = m$, where the value of m is recommended to be taken as $m = 1.25 \dots 1.4$; however, this indicator specifically applies to this particular field.;
- With an increase in the value of the ratio m , as a result of the centrifugal force during relative motion, the share of static pressure increases, hydraulic losses decrease, but the resistance to the airflow along the blade increases.;
- When the value of the ratio m increases, the blade length increases, which leads to higher fan performance and pressure;

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- O reduce the rotational speed of the fan wheel, the value of m is also increased.

Conclusion: Based on the above-mentioned requirements, factors, and recommendations, it was proposed to determine the diameter of the centrifugal fan wheel installed on spraying and dusting equipment according to the recommendation of A.N. Sherstyuk, and it was presented in the following form (7):

$$D = m \cdot D_0 \quad (7)$$

Based on the conducted theoretical and practical studies, the accepted value of the ratio is $m=1.5 \dots 1.7$. The diameter of the fan impeller installed on the technical equipment of the sprayer and duster is determined by the following formula and it is recommended to determine it exactly in this way (8):

$$D = (1,5 \dots 1,7) D_0 \quad (8)$$

The diameter of the centrifugal fan installed on the sprayers and dust collectors is determined using expression (8) and is selected based on GOST 10616-2015, as well as taking into account their external dimensions.

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