UDC 631.312 DOI 10.31548/energiya2022.04.107

INVESTIGATION OF THE MOVEMENT OF A MATERIAL PARTICLE ALONG STRAIGHT-LINE AND CURVILINE BLADES ON A HORIZONTAL DISK ROTATING AROUND A VERTICAL AXIS

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Abstract. *The study of the movement of material particles along a horizontal disc with orthogonally attached blades during its rotation around a vertical axis is the theoretical basis for the design of dispersing bodies of mineral fertilizers.*

The movement of a particle along the rectilinear blades of a horizontal disk rotating around a vertical axis has been thoroughly investigated. Of the curved vanes, we considered a vane in which the profile has the shape of a logarithmic spiral. But it is also important to find a blade profile that would satisfy these conditions based on the given initial conditions.

The purpose of the article is to find a profile of a curved vane that would meet the specified requirements for the movement of a particle along this vane during rotation of a horizontal disk around a vertical axis.

When rotating a disk with a curved blade, the particle performs a complex movement: transferred due to the rotation of the disk and relative along the blade. To compile the differential equations of motion, it is necessary to find the vector of absolute acceleration, which includes three components: acceleration in translational motion, acceleration in relative motion, and Coriolis acceleration.

The generalized differential equations of particle motion along rectilinear and curved vanes are derived. A comparative analysis of the kinematic parameters of motion for different shapes of blades was made.

It was established that with the same angular velocity of rotation of the disk and the same initial conditions, the shape of the curved blade significantly affects the absolute velocity of the particle at the time of its exit from the disk. With the shape of the blade, in which there is no pressure of the particle on it, the absolute speed of the particle is minimal. As the pressure, which is constant along the entire length of the blade, increases, its profile gradually changes, approaching the radial direction, and the absolute speed of the particle increases. However, the maximum absolute speed that can be obtained due to the curved profile of the blade under the condition of constant pressure on it is proportional to the particle speed for rectilinear blades. Under the condition of the same pressure of the particle on the blade at different angular velocities of rotation of the disk, the profiles of the blades will be different, but the absolute speeds of the particle at the time of its exit from the disk will be the same.

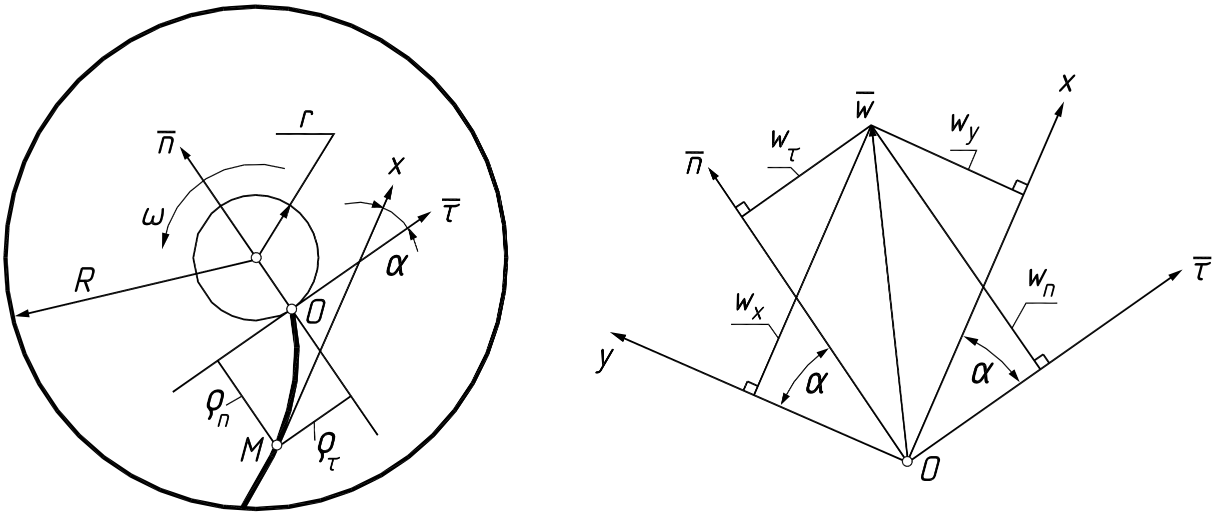
Key words: ***curved and rectilinear vanes, pressure force, differential equations***

Introduction. The study of the movement of material particles along a horizontal disc with orthogonally attached blades during its rotation around a vertical axis is the theoretical basis for the design of dispersing bodies of mineral fertilizers. The operation of dispersing discs with rectilinear blades has been sufficiently studied theoretically. The study of the effect of the shape of the curved blade on the kinematic parameters of the particle movement can be useful in the design of the corresponding working bodies.

Analysis of recent research and publications. The movement of a particle along the rectilinear blades of a horizontal disk rotating around a vertical axis is quite fully investigated in papers [1-3]. As for curved vanes, papers [1, 2] consider a vane whose profile has the shape of a logarithmic spiral. At the same time, the shape of the blade is set in advance and the kinematic parameters of the particle movement are investigated. It is quite logical to pose the inverse problem: to find a blade profile that would satisfy these conditions based on the given initial conditions.

The purpose of the study is to find the profile of a curved vane that would meet the specified requirements for the movement of a particle along this vane during rotation of a horizontal disk around a vertical axis.

Research materials and methods. When rotating a disk with a curved blade, the particle performs a complex movement: transferred due to the rotation of the disk and relative along the blade. To compile the differential equations of motion, it is necessary to find the vector of absolute acceleration, which includes three components: acceleration in translational motion, acceleration in relative motion, and Coriolis acceleration. In work [4] it is shown that this vector is conveniently found in the projections on the orthoses of the accompanying trihedron of the curve of the transfer motion, which will be a circle for the rotational motion of the disk. In Fig. 1a, the periphery of the disc is marked with a larger circle, and the trajectory of the transfer movement is marked with a smaller circle. The accompanying trihedron is rigidly connected to the disc, and ort $\bar{\tau}$ directed along the tangent to the trajectory of the transfer movement in its direction, ort $\bar{n}$ – along the main normal towards the center of curvature, ort $\bar{b}$ – binormal – projected to a point at the origin of the coordinates. We will assume that the curvilinear shape of the blade is given by the dependencies $\rho_\tau = \rho_\tau(s)$ and $\rho_n = \rho_n(s)$, where s – is the arc length of the transfer motion trajectory. Fig. 1a shows the particle in the t. M on the blade and its coordinates are marked ρ_τ in ρ_n the projections on the vertices of the trihedron. The tangent Mx to the scapula at this point makes an $\bar{\tau}$ angle with the ortho α. Thus, the trajectory of the particle's relative motion is determined by the shape of the curved blade.



a *b*

Fig. 1. Graphic illustrations for compiling the differential equations of motion of a particle along a curved disk blade:

a – curvilinear blade in the system of the accompanying trihedron of the trajectory of the transfer movement - a circle of radius *r*; *b* – vector of absolute acceleration $\overline{W}$ in projections on the axis of two systems forming an angle between them α

Research results and their discussion. Theoretical results of finding the absolute acceleration of a point on the vertices of the accompanying trihedron during its movement along a known trajectory in the system of this trihedron were obtained in the paper [4]. According to these results, for our case, the absolute acceleration will be written:

$$\overline{W} = \bar{\tau} v_e^2 \left(\rho_\tau'' - 2k\rho_n' - k^2\rho_\tau\right) + \bar{n} v_e^2 \left(\rho_n'' + 2k\rho_\tau' - k^2\rho_n + k\right), \quad (1)$$

where is $k = 1/r$ – the curvature of the trajectory of the transfer motion; v_e – the speed of the transfer of the origin of the coordinates of the trihedron along the circle of radius r.

Since the movement of the particle occurs in the direction of the tangent Mx , then the differential equation of motion must be added in the projection onto this tangent. To do this, we project the absolute acceleration vector onto the direction of the tangent and onto the direction perpendicular to it. We write down the components of the absolute acceleration vector (projection onto the vertices of the trihedron):

$$W_\tau = v_e^2\left(\rho_\tau'' - 2k\rho_n' - k^2\rho_\tau\right); \quad W_n = v_e^2\left(\rho_n'' + 2k\rho_\tau' - k^2\rho_n + k\right). \tag{2}$$

Fig. 1b shows the vector of absolute acceleration $\overline{W}$ in the projections on the vertices of the accompanying trihedron and on the axis Ox and Oy, which are, respectively, tangent and normal to the blade. Let's establish a relationship between these projections, based on the fact that there is an angle between the coordinate axes of both systems α. We project each of the components W_τ and W_n onto the axis Ox and Oy and we obtain by the well-known formulas for rotation of the axes:

$$W_x = W_\tau \cos\alpha + W_n \sin\alpha; \qquad W_y = -W_\tau \sin\alpha + W_n \cos\alpha. \tag{3}$$

Since $\alpha -$ the angle it forms is tangent to the scapula with ortho $\overline{\tau}$, it is known that $\mathrm{tg}\alpha = \dfrac{\rho_n'}{\rho_\tau'}$, from where:

$$\cos\alpha = \frac{\rho_\tau'}{\sqrt{\rho_\tau'^2 + \rho_n'^2}}; \qquad \sin\alpha = \frac{\rho_n'}{\sqrt{\rho_\tau'^2 + \rho_n'^2}}. \tag{4}$$

Substituting (2) and (4) into (3), we obtain the projections of the absolute acceleration vector on the system axis Oxy:

$$W_x = \frac{v_e^2}{\sqrt{\rho_\tau'^2 + \rho_n'^2}}\left[\left(\rho_\tau'' - 2k\rho_n' - k^2\rho_\tau\right)\rho_\tau' + \left(\rho_n'' + 2k\rho_\tau' - k^2\rho_n + k\right)\rho_n'\right];$$
$$W_y = \frac{v_e^2}{\sqrt{\rho_\tau'^2 + \rho_n'^2}}\left[-\left(\rho_\tau'' - 2k\rho_n' - k^2\rho_\tau\right)\rho_n' + \left(\rho_n'' + 2k\rho_\tau' - k^2\rho_n + k\right)\rho_\tau'\right]. \tag{5}$$

does not move $F = mW_y$ in the direction of the axis, so the force is Oy balanced by the force of the particle's pressure on the blade. We will assume that the coefficient of friction of the f particle on the surface of the disk and on the surface of the blade is the same, so the total force of friction will be written:

$$F_{\text{тер.}} = fmg + fmW_y =$$
$$= fmg + fm\frac{v_e^2}{\sqrt{\rho_\tau'^2 + \rho_n'^2}}\left[-\left(\rho_\tau'' - 2k\rho_n' - k^2\rho_\tau\right)\rho_n' + \left(\rho_n'' + 2k\rho_\tau' - k^2\rho_n + k\right)\rho_\tau'\right], \text{ -(6)}$$

where m – is the mass of the particle; $g = 9.81\ m/s^2$.

The only applied force will be the frictional force directed in the direction opposite to the particle's motion. Thus, the differential equation of motion of the particle in the projection onto the tangent (axis Ox) will be written:

$$\frac{mv_e^2}{\sqrt{\rho_\tau'^2 + \rho_n'^2}}\left[\left(\rho_\tau'' - 2k\rho_n' - k^2\rho_\tau\right)\rho_\tau' + \left(\rho_n'' + 2k\rho_\tau' - k^2\rho_n + k\right)\rho_n'\right] =$$
$$= -fmg - f\frac{mv_e^2}{\sqrt{\rho_\tau'^2 + \rho_n'^2}}\left[-\left(\rho_\tau'' - 2k\rho_n' - k^2\rho_\tau\right)\rho_n' + \left(\rho_n'' + 2k\rho_\tau' - k^2\rho_n + k\right)\rho_\tau'\right]. \quad (7)$$

Taking into account that $v_e = \omega r = \omega/k$, where is ω – the angular speed of rotation of the disk, as well as shortening by mass m, equation (7) can be written:

$$\frac{\omega^2}{k^2\sqrt{\rho_\tau'^2 + \rho_n'^2}}\left[\left(\rho_\tau'' - 2k\rho_n' - k^2\rho_\tau\right)\rho_\tau' + \left(\rho_n'' + 2k\rho_\tau' - k^2\rho_n + k\right)\rho_n'\right] =$$
$$= -fg - f\frac{\omega^2}{k^2\sqrt{\rho_\tau'^2 + \rho_n'^2}}\left[-\left(\rho_\tau'' - 2k\rho_n' - k^2\rho_\tau\right)\rho_n' + \left(\rho_n'' + 2k\rho_\tau' - k^2\rho_n + k\right)\rho_\tau'\right]. \quad (8)$$

The differential equation (8) cannot be solved without imposing additional conditions, since it includes two unknown dependencies $\rho_\tau = \rho_\tau(s)$ and $\rho_n = \rho_n(s)$. Such conditions can impose restrictions on the shape of the blade or, for example, the magnitude of the particle pressure on it. You can look for such a shape of the blade so that the pressure on it is equal to zero; in this case, its profile will coincide with the relative trajectory of the particle's movement on the disc without a blade. To describe this case, it is necessary to equate the expression in the last square brackets of equation (8) to zero. This will be an additional condition. The resulting system of equations after simple transformations can be reduced to the form obtained in work [4] (formula (44), p. 281) when solving the problem of finding the relative trajectory and motion of a particle on the surface of a rough disk without blades.

Consider the case when $\rho_n = \rho_n' = \rho_n'' = 0$. This means that the movement of the particle will occur along a rectilinear vane located at a distance r from the center of the disk (the vane coincides with the ortho τ). In this case, equation (8) takes the form:

$$\rho_\tau'' + 2fk\rho_\tau' - k^2\rho_\tau = -\frac{fk}{\omega^2}\left(\omega^2 + gk\right). \qquad (9)$$

Equation (9) is linear and can be integrated . Its solution is a dependency:

$$\rho_\tau = f\,\frac{\omega^2 + gk}{k\omega^2} + c_1 e^{-\left(\sqrt{1+f^2}+f\right)ks} + c_2 e^{\left(\sqrt{1+f^2}-f\right)ks}, \qquad (10)$$

where $c_1,\ c_2$ – constant integrations.

When $\rho_\tau = \rho_\tau' = \rho_\tau'' = 0$ the particle will move along a rectilinear disk blade fixed in the radial direction. Equation (8) takes the form:

$$\rho_n'' + 2fk\rho_n' - k^2\rho_n = -\frac{k}{\omega^2}\left(\omega^2 + fgk\right). \qquad (11)$$

The solution of equation (11) is the dependence:

$$\rho_n = \frac{fg}{\omega^2} + r + c_1 e^{\left(-f-\sqrt{1+f^2}\right)ks} + c_2 e^{\left(-f+\sqrt{1+f^2}\right)ks}. \qquad (12)$$

In equations (10), (12) the independent variable is the arc coordinate s of the trajectory of the transfer movement of the trihedron. In known works on the movement of a material particle on rough surfaces [1-3], the independent variable is time t. Taking into account the constant angular speed ω of the disk rotation, we can write:

$$s = r\omega t = \frac{\omega t}{k}. \qquad (13)$$

Substitution (13) in (10) and (12) gives dependences in the time function as ρ_τ well ρ_n:

$$\rho_\tau = f\left(\frac{g}{\omega^2} + r\right) + c_1 e^{-\left(\sqrt{1+f^2}+f\right)\omega t} + c_2 e^{\left(\sqrt{1+f^2}-f\right)\omega t}. \qquad (14)$$

$$\rho_n = \frac{fg}{\omega^2} + r + c_1 e^{\left(-f-\sqrt{1+f^2}\right)\omega t} + c_2 e^{\left(-f+\sqrt{1+f^2}\right)\omega t}. \qquad (15)$$

Equation (14) exactly coincides with a similar equation in work [2] (equations (7.1.8), (7.1.9), p. 366), although they were obtained with completely different approaches.

Equation (15) differs only in the front sign r from the similar equation in work [3] (equation (8), p. 23), however, when selecting the appropriate initial conditions, it is possible to show their complete correspondence.

Now let's find the shape of the blade, which would ensure a constant pressure of the particle on it. We will compare the amount of pressure on the blade with the amount of pressure on the disc. The force of pressure on the blade is denoted by the expression $F_{тис} = pmg$, where p – is the coefficient. At p >1, the pressure on the blade will be p twice as high as on the disc and vice versa.

From taking into account this one superimposed additional conditions equation (7) turns into the system:

$$\begin{cases} mW_y = pmg; \\ mW_x = fmg(1+p). \end{cases} \tag{16}$$

After _ abbreviation equations system (16) per mass *m* and substitutions W_x and W_y with (5) simple transformations, we reduce it to the form:

$$\begin{cases} \rho''_\tau - 2k\rho'_n - k^2\rho_\tau = -\dfrac{gk^2}{\omega^2\sqrt{\rho'^2_\tau + \rho'^2_n}}\left[\dfrac{p}{f}\rho'_n + (f+p)\rho'_\tau\right] \\ \rho''_n + 2k\rho'_\tau - k^2\rho_n + k = \dfrac{gk^2}{\omega^2\sqrt{\rho'^2_\tau + \rho'^2_n}}\left[\dfrac{p}{f}\rho'_\tau - (f+p)\rho'_n\right] \end{cases}. \tag{17}$$

When *p =0*, the obtained formulas (17) exactly coincide with the formulas in the article [4] (formula (44), p . 281).

Integration system (17) using numerical methods showed the following results0.

At *p =0*, the curved blade has the form in which missing pressure on her with extraneous particles _ In fig. 2, and the following ones trajectory relative movement (i.e blade profile) is marked letter *L* (blade) with a number equal to the value of the coefficient *p*, and the absolute trajectory has similar marking from that by the difference that is in front of the number letter *T* (trajectory). From fig. 2, it can be seen that a particle that has made approximately half a revolution slides along a circle of radius *r* , and then moves away to the periphery of the disk, making almost two revolutions. This is fully consistent with the data obtained in work [2] at the angular speed of disk rotation *ω= 25 rad/s* (Fig. 7.3.2, page 417).

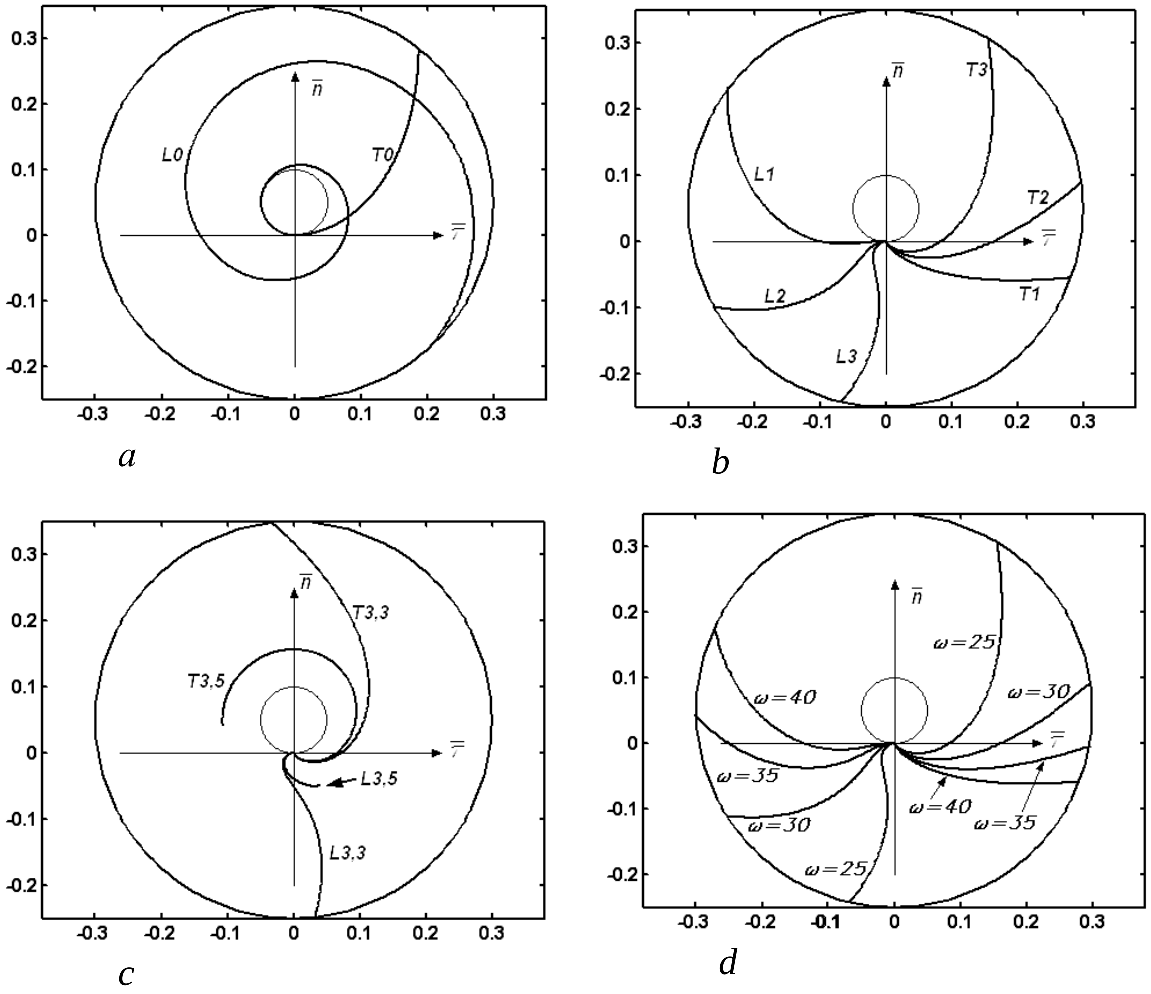
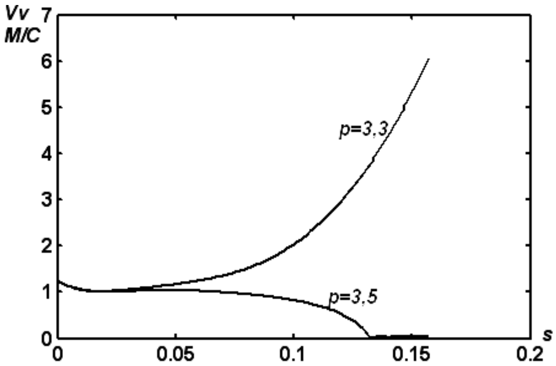


Fig. 2. Profiles of curved vanes and the corresponding absolute trajectories of particle movement at different angular speeds of rotation and values of the coefficient *p*:

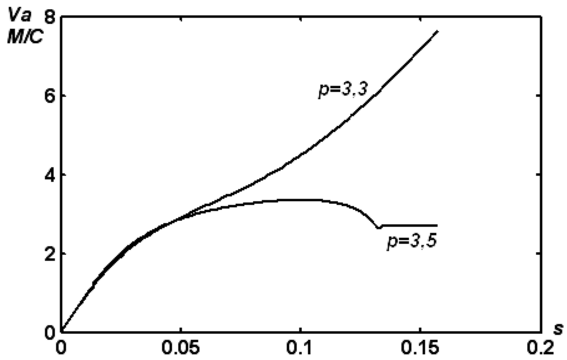
a – ω=25 rad/s; p = 0; *b – ω=25 rad/s; p = 1; 2; 3;*

c – ω=25 rad/s; p = 3.3; 3.5; *d – ω=25; 30; 35; 40 rad/s; p = 3*

At the moment of departure from the disc, the particle's absolute speed reaches *1.13 m /s*. When the coefficient *p increases, the* shape of the blade changes, getting closer to the radial direction. At the same time, the absolute trajectory also changes (Fig. 2b). As the coefficient *p increases,* the relative velocity of the particle decreases, but the absolute velocity increases. This has its own explanation. Absolute speed is the geometric sum of velocities in translational and relative movements. At *p=0* , the vectors of these velocities are directed along straight lines, the angle between which is close to 180 ^{0}, that is, they have the opposite direction, so the geometric sum of their components is close to the difference in absolute values. As the coefficient *p increases, the* angle between the direction of action of these speeds approaches 90 ^{0}, so the geometric sum (absolute speed) increases. With further growth of the coefficient *p* , the moment comes when it is impossible to build a blade that would ensure the given condition. In fig. 2, c shows the shape of the blade and the absolute trajectory for two values of the coefficient *p* : *p=3.3* and *p=3.5* . If everything is clear for *p=3.3*, then for *p=3.5 it* is clear that only a limited part of the scapula can fulfill this condition. The absolute trajectory at *p=3.5* turns into a circle. This can be understood from the graphs of relative (Fig. 3, *a*) and absolute (Fig. 3, *b*) velocities.



a



b

Fig. 3. Graphs of the relative and absolute speeds of particle movement at different values of the coefficient *p*:

a – graphs of relative speeds; *b* – graphs of absolute speeds

It can be seen from them that at *s* ≈*0.13 m* the relative velocity of the particle becomes zero. The particle moved along the blade and stopped in relative motion, continuing to rotate together with the disc with a constant absolute speed in a circle equal to the transfer speed of the end of the blade (Fig. 3, *b*). Thus, by increasing the pressure on the blade, we can find its shape for the limit value *p* for which movement is still possible. At the same time, the absolute speed at the moment of descent from the disk reaches its maximum value (in our case, *7.64 m /s* for *p=3.3*). In the work [2], the value of *8.93 m/s* is given for a rectilinear blade under similar initial conditions (p. 376).

Fig. 2, *d* shows the profiles of the blades and the trajectory of the absolute movement for different angular speeds of the disc rotation and a constant value of the coefficient *p=3*. At the same time, it was found that in all cases the absolute speed of the particle at the time of exit from the disc will be the same and equal to *7.25 m/s*.

The limited scope of the article does not allow us to give the formulas for determining the relative and absolute velocities and the absolute trajectory of the particle movement, which we used. Their strict mathematical derivation is given in the work [4].

When *p is* introduced, the friction force (6) becomes constant, since the following components are constant: the friction force of the particle on the disk and on the blade. Therefore, in equation (7), the right-hand side is constant, from which it follows that the left-hand side must also be a constant value. But the left part represents a driving force directed in the direction of movement opposite to the force of friction. Thus, the ratio of the driving force to the weight of the particle will also be a constant value, denoted by *q* . It is clear that between the coefficients *p* and *q* there is a relationship. Having passed conversion on input coefficient *q* similarly to the transformations when the coefficient *p* is introduced, we obtain:

$$\begin{cases} \rho_\tau'' - 2k\rho_n' - k^2\rho_\tau = \dfrac{gk^2}{\omega^2\sqrt{\rho_\tau'^2+\rho_n'^2}}\left[q\rho_\tau' + \left(\dfrac{f+q}{f}\right)\rho_n'\right] \\ \rho_n'' + 2k\rho_\tau' - k^2\rho_n + k = \dfrac{gk^2}{\omega^2\sqrt{\rho_\tau'^2+\rho_n'^2}}\left[q\rho_n' - \left(\dfrac{f+q}{f}\right)\rho_\tau'\right] \end{cases}. \tag{18}$$

At comparing systems (17) and (18) shows that they are on the left parts similar. Equating right part, we obtain the relationship between the coefficients *p* and *q*:

$$p + q = -f. \tag{19}$$

From dependence (19), it is possible to establish a relationship between the coefficients *p* and *q* for the same blade shape. If the blade is calculated for a certain value of the coefficient *p* , then the coefficient *q* for the same blade is found from the expression *q = -(f + p)* , where the opposite signs in front of the coefficients indicate the opposite directions of action of the driving force and friction force.

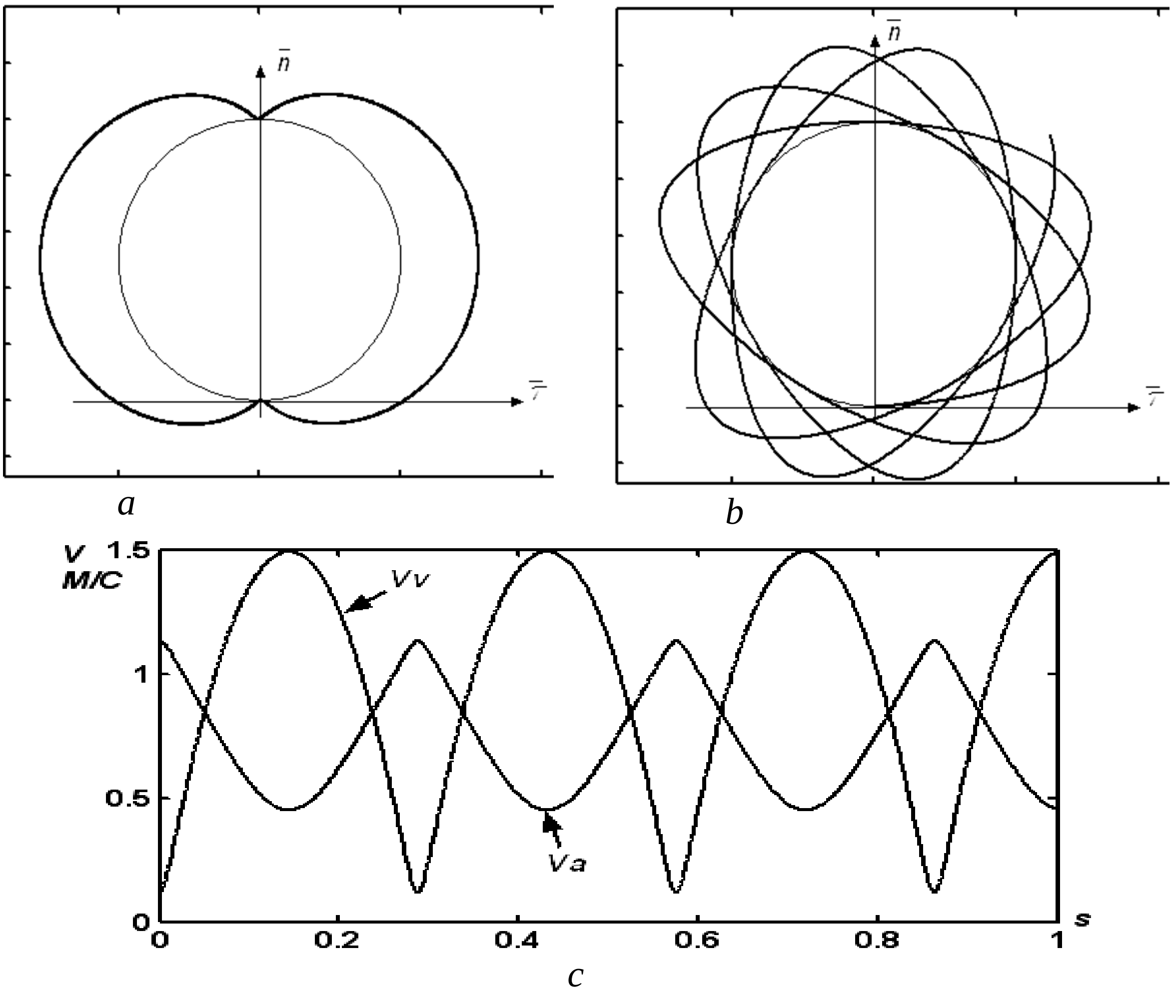


Fig. 4. Kinematic parameters of particle motion at *ω=25 rad / s* and *q =0:*

a – shape of a curved blade; *b* – absolute trajectory of particle motion; *c* – graphs of relative V_v and absolute V_a speeds

It remains to determine the shape of the blade at *q =0*. From the definition of the coefficient *q*, it follows that the driving force will be equal to zero, so the particle in relative motion must remain at rest. However, the integration of system (18) at *q =0* shows that this is not the case. In fig. 4 shows the shape of the blade, the absolute trajectory of the particle, and graphs of relative and absolute velocities. The initial conditions are selected so that the blade has a closed form and consists of two symmetrical parts. The particle slides along the inside of the blade without leaving the disc. At the same time, the relative and absolute speeds have a periodic character. At the moment when the relative speed (the speed of sliding along the blade) is minimal, the absolute one acquires a maximum value, which was to be expected, since the absolute speed of the particle in this case is closest to the transfer one.

Obviously, this shape of the blade is not suitable for scattering loose materials. As for the theoretical explanation of this shape of the scapula, it is as follows. When $p=0$ in system (17) and when $q=0$ in system (18), their right parts are a vector tangent to the trajectory of the relative motion, that is, to the blade profile. It can be shown that they are mutually perpendicular. This means that the driving force directed tangentially in the first case becomes perpendicular to the blade in the second. But the particle does not move in this direction, therefore, at $q=0$ in system (18), the value of the coefficient f has no significance. The particle is forced to move by a force that is directed tangentially to the blade in the second case, and in the first case was perpendicular to it, i.e., the former force of pressure on the blade.

Summarizing the obtained solutions of differential equations (10) and (12) for rectilinear vanes and systems of differential equations (17) and (18) for curved vanes and their analysis under the same initial conditions, the following can be summarized.

Conclusions and perspectives. At the same angular speed of rotation of the disk and the same initial conditions, the shape of the curved blade significantly affects the absolute velocity of the particle at the time of its exit from the disk. With the shape of the blade, in which there is no particle pressure on it (that is, in the case when the profile of the blade copies the trajectory of the relative movement of the particle on a disk without blades), the absolute speed of the particle is minimal. As the pressure, which is constant along the entire length of the blade, increases, its profile gradually changes, approaching the radial direction, and the absolute speed of the particle increases. However, the maximum absolute speed that can be obtained due to the curved profile of the blade under the condition of constant pressure on it is proportional to the particle speed for rectilinear blades. Provided the particle pressure is the same on the blade at different angular velocities of the disc rotation, the profiles of the blades will be different, but the absolute velocities of the particle at the time of its exit from the disc will be the same.

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ДОСЛІДЖЕННЯ РУХУ МАТЕРІАЛЬНОЇ ЧАСТИНКИ ВЗДОВЖ ПРЯМОЛІНІЙНИХ І КРИВОЛІНІЙНИХ ЛОПАТОК НА ГОРИЗОНТАЛЬНОМУ ДИСКУ, ЯКИЙ ОБЕРТАЄТЬСЯ НАВКОЛО ВЕРТИКАЛЬНОЇ ОСІ

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Анотація. *Дослідження руху матеріальних частинок по горизонтальному диску із ортогонально прикріпленими лопатками при його обертанні навколо вертикальної осі є теоретичною основою при проектуванні розсіювальних органів мінеральних добрив.*

Рух частинки вздовж прямолінійних лопаток горизонтального диска, що обертається навколо вертикальної осі, досить повно досліджено. Із криволінійних лопаток розглянуто лопатку, в якої профіль має форму логарифмічної спіралі. Але також важливо за заданими вихідними умовами знаходити профіль лопатки, який задовольнив би ці умови.

Метою статті є знаходження профіля криволінійної лопатки, який відповідав би заданим вимогам руху частинки вздовж цієї лопатки при обертанні горизонтального диска навколо вертикальної осі.

При обертанні диска із криволінійною лопаткою частинка здійснює складний рух: переносний за рахунок обертання диска і відносний вздовж лопатки. Для складання диференціальних рівнянь руху необхідно знайти вектор абсолютного прискорення, який включає три складові: прискорення у переносному русі, прискорення у відносному русі і прискорення Коріоліса.

Отримано узагальнені диференціальні рівняння руху частинок уздовж прямолінійної та криволінійної лопаток. Проведено порівняльний аналіз кінематичних параметрів руху для різних форм лопатей.

Встановлено, що при однаковій кутовій швидкості обертання диска і однакових початкових умовах форма криволінійної лопатки суттєво впливає на величину абсолютної швидкості частинки в момент її сходу із диска. При формі лопатки, за якої відсутній тиск частинки на неї, абсолютна швидкість частинки мінімальна. По мірі зростання тиску, який є постійним по всій довжині лопатки, її профіль поступово змінюється, наближаючись до радіального напряму, а абсолютна швидкість частинки зростає. Однак максимальна абсолютна швидкість, яку можна одержати за рахунок криволінійного профілю лопатки за умови постійного тиску на неї співрозмірна із швидкістю частинки для прямолінійних лопаток. За умови однакового тиску частинки на лопатку при різних кутових швидкостях обертання диска профілі лопаток будуть різними, проте абсолютні швидкості частинки в момент сходу її з диска будуть однаковими.

Ключові слова: ***криволінійні та прямолінійні лопатки, сила тиску, диференціальні рівняння***