DOI https://doi.org/10.30525/978-9934-26-205-0-2

INFLUENCE OF ALTERNATING OSCILLATIONS OF CUTTER KNIVES ON THEIR STRESS-STRAIN STATE AND FATIQUE ENDURANCE

Batrachenko O. V.

INTRODUCTION

Cutters are known to be one of the main types of meat processing equipment. The main working parts of the cutter are crescent-shaped knives, the design of which depends on the efficiency of processing raw materials in the cutter and the durability of the machine itself. Knives in their work are a subject to alternating oscillations, which directly limits their durability. It is important to find ways to increase the strength and durability of cutter blades.

1. The Force of Raw Materials on the Knife

To determine the stress-strain state of the knives, it is necessary, first of all, to determine the forces acting on it during operation. The magnitude of the effort depends significantly on the cutting angle. Minimizing the blade cutting angle is especially important for cutter blades. This is achieved by kinematic transformation of the cutting angle (Fig. 1) – when using curved blades cutting angle β_1 always less than the sharpening angle β.

The effect of the blade sharpening angle on the resistance of its movement through the raw material and, accordingly, on the value of the pressure on the surface of the knife blade remains unexplored. This does not allow to obtain high accuracy when calculating the cutter blades for strength and does not allow to determine effective ways to further improving them.

A three-dimensional model of the laminar motion of an incompressible viscous fluid based on the Navier-Stokes equations and the continuity of the medium was chosen for modeling:

$$\frac{\partial \vec{\upsilon}}{\partial t} + \left(\vec{\upsilon} \cdot \nabla\right) \cdot \vec{\upsilon} = \frac{1}{\rho}\nabla p + \frac{1}{\rho}\nabla(\mu\nabla\vec{\upsilon}) + \vec{S}, \qquad div\,\vec{\upsilon} = 0 \tag{1}$$

where $\vec{\upsilon}$ – vector field of velocities; t – time; p – pressure; ρ – density; μ – dynamic viscosity; $\vec{S}$ – mass forces.

The boundary conditions were set as follows (in terms of FlowVision):

– at the entrance to the settlement area – input, normal speed – $\upsilon_n\big|_p = \upsilon_0$;

– upper, lower and rear faces of the settlement area – free exit – $p|_p = 0$; $\upsilon|_p = \upsilon_\tau|_p$ at $(\vec{\upsilon}, \vec{n}) > 0$, $\nabla(\upsilon_i, \vec{n})|_{гр} = 0$ at $(\vec{\upsilon}, \vec{n}) \le 0$.

– knife surface – wall, logarithmic law, taking into account the value of sand roughness in microns – $\upsilon_n|_p = 0$,; $\tau|_p = \mu \left.\frac{\partial \upsilon}{\partial y}\right|_{\upsilon=0}$;

– side surfaces of the calculation area – symmetry, wall with slipping – $\upsilon_n|_p = 0$, $\left.\frac{\partial \upsilon_\tau}{\partial n}\right|_p = 0$;

Here $\upsilon_n, \upsilon_\tau$ – are normal and tangential components of velocity vectors, $\upsilon_i, i = 1, 2, 3$ – is projection of the velocity vector on the coordinate axis, $\vec{n}$ – is vector normal to the limit.

The following initial data were used to model the cutting mode of lump steamed raw meat and its minced meat in the cutter: the velocity of the liquid in determining the frontal pressure was set in the range from 50m/s to 200 m/s (as when rotating knives); fluid movement mode – laminar; fluid density 1050 kg/m^3, fluid viscosity 30-700 Pa·s. The values of the blade sharpening angle were as follows: 2°, 5°, 8°, 11°, 14°.

Numerical modeling of raw material hydrodynamics during knife movement was performed in the FlowVision software package. As a result of modeling, the distribution of fluid pressure during frontal flow of the blade was determined. Visualization of the obtained results is shown in Fig. 2, 3 (for individual cases).

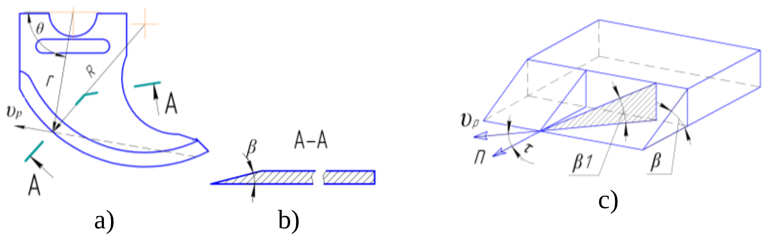


Fig. 1. Scheme for determining the kinematic angle of cutting:

a) cutter knife (as an example, the scheme of the cutter knife Л5-ФКБ, the blade of which is made in the form of an arc of a circle with radius R); b) cross section of the knife; c) section of the knife in the direction of the cutting speed υ_P; θ – is the current angle that determines the position of the point on the blade; r – is the radius of rotation of the blade point; υ_P – is the cutting speed; n – normal to the tangent to the blade of the knife; τ – is the sliding angle; β– is the angle of sharpening of the blade; β_1 – is kinematic cutting angle

The results obtained by numerical simulation (Fig. 4-6) were approximated by the method of least squares, resulting in the following multiple regression equation:

$$P = -4,69 + 0,32 \cdot \beta^2 + 0,0261 \cdot \upsilon + 0,0035 \cdot \eta \qquad (2)$$

wher P – is the value of pressure, MPa;
β – is the angle of sharpening of the blade, deg .;
υ –is the cutting speed, m/s; η – is the viscosity of the raw material Pa·s.

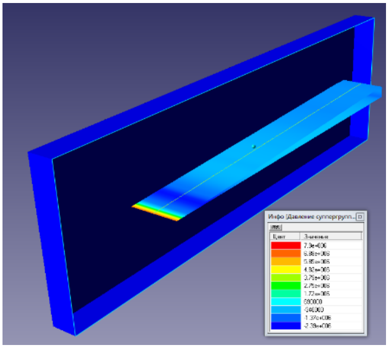


Fig. 2. Distribution of fluid pressure during the front flow of the blade (angle of sharpening of the blade β =2 deg., cutting speed υ=200 m/s, viscosity of raw materials η=30 Pas·s)

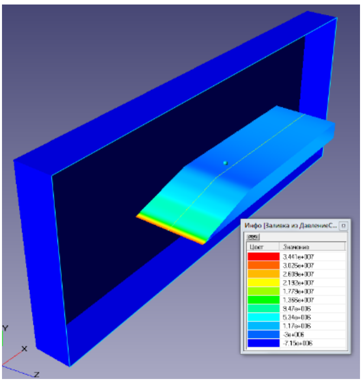


Fig. 3. Distribution of fluid pressure during the front flow of the blade (angle of sharpening of the blade β =14 deg., cutting speed υ=200 m/s, viscosity of raw materials η=30 Pas·s)

As follows from the simulation results, changing the sharpening angle of the blade significantly affects the pressure acting on the surface of the knife blade. Thus, at a flow rate of 50 m/s, changing the angle β from 2° to 14° leads to a change in blade pressure from 0,05 MPa to 1,37 MPa, depending on the viscosity of the raw material.

At a flow rate of 200 m/s, the pressure on the blade varies from 0,69 MPa to 13,66 MPa, respectively.

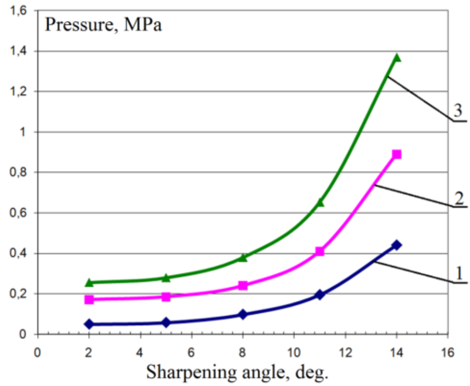


Fig. 4. The average values of the pressure acting on the cross section of the knife during cutting, at a cutting speed υ= 50 m/s and the following values of viscosity of raw materials: 1 – η= 30Pa·s; 2 – η= 200Pa·s; 3 – η= 700Pa·s

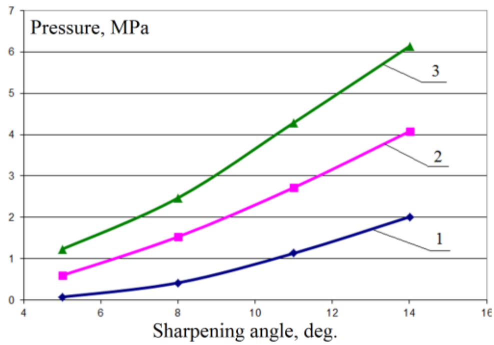


Fig. 5. The average values of the pressure acting on the cross section of the knife during cutting, at a cutting speed υ= 125 m/s and the following values of viscosity of raw materials: 1 – η= 30Pa·s; 2 – η= 200Pa·s; 3 – η= 700Pa·s

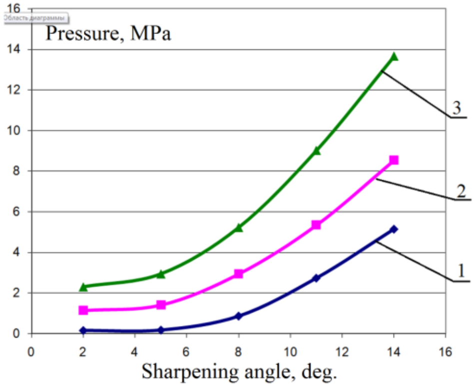


Fig. 6. The average values of the pressure acting on the cross section of the knife during cutting, at a cutting speed υ= 200 m/s and the following values of viscosity of raw materials: 1 – η= 30Pa·s; 2 – η= 200Pa·s; 3 – η= 700Pa·s

At the same time, the greater the viscosity of the raw material flow is, the more pronounced the increase in pressure with increasing sharpening angle becomes. This indicates the need to take into account these design parameters when determining the power load conditions of the cutter blades and when calculating their strength.

2. Influence of Vibration Loads on the Stress-strain State of the Cutter Blades

Modern designs of cutters in accordance with technological requirements have intensified modes of operation. As a result, the problem of ensuring the proper strength and durability of cutter blades is faced by manufacturers of cutting tools in a new format.

Speaking of finding ways to solve this problem, along with these factors of the force load of knives, I would like to note another one, which, in our opinion, has not yet received sufficient attention from researchers. This factor is the vibration loadof the cutter blades.

Performing up to 100 s^{-1} and at the same time having periodic contact with raw materials, it performs up to 100 oscillations per second due to deformation during cutting raw materials. Since theyhave relatively high frequency of oscillations of knives, a considerable length and small thickness, it is to be assumed that their operation may cause resonance, which is able to lead to a sharp increase in body deformation and its destruction. The study of the oscillation parameters of the cutter blades can provide an opportunity to determine rational ways to increase their strength and, consequently, durability.

The natural oscillation frequencies of 6 types of knife designs (Fig. 7), which are most often used in modern models of cutters, were studied. According to Figure 7 knives of the presented types belong to cutters of the following brands: type I – Seydelmann; type II and III – Laska; type IV – Kilia; type V – Alpina; type VI–Л5-ФКБ.

The study of natural frequencies was performed by numerical mathematical modeling. 3D – models were built for each type of knife, with a maximum radius of rotation of the knife points of 300 mm, and the thickness of the knife took three values, each of which was determined by the scale factor k (k_1 = 42,9; k_2 = 60; k_3 = 85,7). The scale factor k was calculated by the expression:

$$k = \frac{R}{S}, \quad (3)$$

where R is the maximum radius of rotation of the points of the knife blade. mm; S is the thickness of the knife, mm.

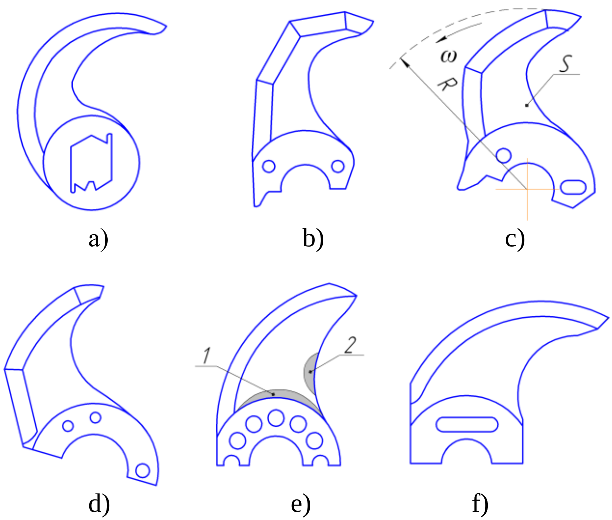


Fig. 7. Schemes of knife designs that are most often used in practice:

a) – type I; b) – type II; c) – type III; d) – type IV; e) – type V; f) – type VI, R – the largest radius of rotation of the points of the knife blade; S –is the thickness of the knife; ω–is the direction of rotation of the knife when grinding raw materials; 1, 2 – areas of greatest stress in the body of the knife under its static load

The values of k were determined according to the value of k_1 corresponding to the knives with the largest specific thickness, and the value of k_3 to the knives with the smallest specific thickness. The use of the scale factor k allows to obtain simulation results that can be interpreted for cutter blades of different performance, as well as for cutters with bowls of different volume, the blades of which have different lengths. In this case, for knives with R = 300 mm, the values of the scale factor k corresponded to the following values of the thickness of the knife: at k = 42,9 – S = 7 mm; at k = 60 – S = 5 mm; at k_3 = 85,7 – S = 3,5 mm.

Alloy steel with a yield strength of 620,4 MPa was chosen as the material of the knives (the value of the yield strength corresponds to the grade of steel 65Г, which is widely used by domestic manufacturers for the manufacture of cutter knives).

Visualization of the obtained results (for some types of knives) is shown in Fig. 8, 9. The values of the natural frequencies of oscillations of knives are given in Table 1, and, having the actual modes of operation of modern cutters, only the first two natural frequencies of natural oscillations ν_{own1} and $\nu_{own.2}$ were determined.

The obtained data were approximated by the method of least squares by the quadratic function of the form:

$$\nu_{власн.1} = a + b \cdot k + c \cdot k^2 \quad (4)$$

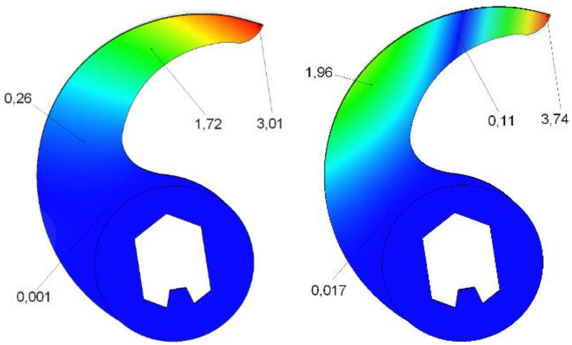
where $\nu_{vlasn.1}$ – the first natural frequency of the knife, Hz;
k – is the scale factor; a, b, c – coefficients (determined by table 2).

According to the obtained data, knives of all studied types, when used in modern high-speed cutters, work in the range of frequencies close to resonance or can work in resonance mode. At the same time, for knives of type I of reduced thickness, the passage of the first resonant frequency and approaching the second (48,9 Hz and 121,3 Hz, respectively) is observed, which indicates their extremely low vibration resistance.

In order to reflect the effect of vibration load of knives on their stress-strain state, the concept of the coefficient of dynamism was used, which was determined by the expression:

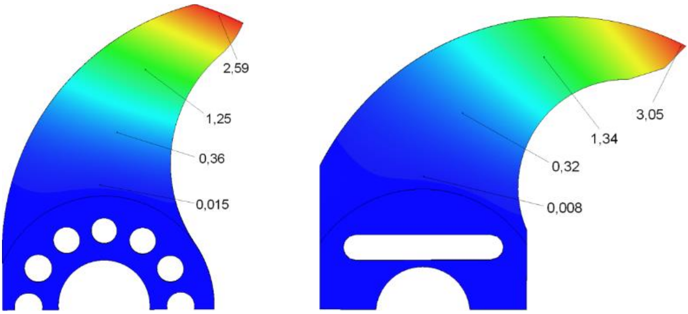
$$\beta = \frac{A}{x_{cm}} = \frac{1}{1 - \frac{\nu_{вим.}^2}{\nu_{власн.}^2}}, \quad (5)$$

where A is the amplitude of forced oscillations;
x_{st} – the amount of deformation under static load of the knife;
$\nu_{vim.}$ – frequency of forced oscillations of the knife, Hz;
ν_{own} – natural oscillation frequency of the knife, Hz.



a) b)

Fig. 8. The value of the relative displacements of the knife type I when it reaches: a) the first natural frequency of oscillation $\nu_{own.1}$; b) the second natural frequency of oscillation $\nu_{own.2}$



a) b)

Fig. 9. The value of the relative displacements of the knives when they reach the first natural frequency of oscillation $\nu_{own.1}$: a) knife type V; b) knife type VI

The coefficient of dynamism β indicates how much the amplitude of the forced oscillations is greater than the deformation of the body under the action of static load. When approaching the frequency of forced oscillations ν_{vim}. to the frequency of natural oscillations $\nu_{own.}$ the value of the coefficient of dynamism β increases rapidly, which indicates a sharp increase in the deformation of the knife under the action of vibration load.

Table 1

The value of the first $\nu_{property1}$ and the second $\nu_{property.2}$ of the natural frequencies of the knives

The type of knife	Natural frequency $\nu_{vlasn.1}/\nu_{vlasn.2}$, Hz			The type of knife	Natural frequency $\nu_{vlasn.1}/\nu_{vlasn.2}$, Hz		
	Scale factor k				Scale factor k		
	42,9	60	85,7		42,9	60	85,7
I	97,0 / 241,0	69,6 / 172,8	48,9 / 121,3	IV	177,2 / 469,2	127,1 / 337,5	89,1 / 237,2
II	134,4 / 400,5	96,4 / 288,1	67,7 / 202,7	V	186,0	133,3 / 428,4	93,5 / 301,1
III	170 / 460,4	121,9 / 330,9	85,6 / 232,5	VI	181,5 / 500,5	130,2 / 359,9	91,3 / 252,9

Table 2

Values of regression equation coefficients

The type of knife	Values of coefficients			The type of knife	Values of coefficients		
	a	b	c		a	b	c
I	213,665	-3,518	0,019	IV	390,166	-6,419	0,034
II	296,218	-4,880	0,026	V	410,421	-6,768	0,036
III	374,890	-6,180	0,033	VI	399,591	-6,573	0,035

In turn, according to Hooke's law, within the elastic deformation stresses σ arising in the body are directly proportional to the relative deformations of this body. Thus, the stresses $\sigma_{vibr.}$, arising in the body under the action of vibration load, β times greater than the stress $\sigma_{stat.}$, arising in the body under the action of static load.

Therefore, the value of the coefficient of dynamism β allows you to quantify how much the stress state of the body will change during the transition from static application of load to vibration. Using the data in Table 1, expression (5) was used to calculate the values of the coefficient of dynamism β for the most widely used frequency ranges of knives in modern cutters. The calculated values are given in table 3, with only the values that precede the achievement of the first natural frequency of oscillation of the knives ν_{own1}.

The obtained data allowed to build the corresponding graphical dependences of the coefficient of dynamism β for knives of the studied types (examples are shown in Fig. 10-15) taking into account different values of the scale factor $_k$. The values of the resonant oscillation frequencies of the knives ($\nu_{own\ 1}$) are shown in the dotted figures.

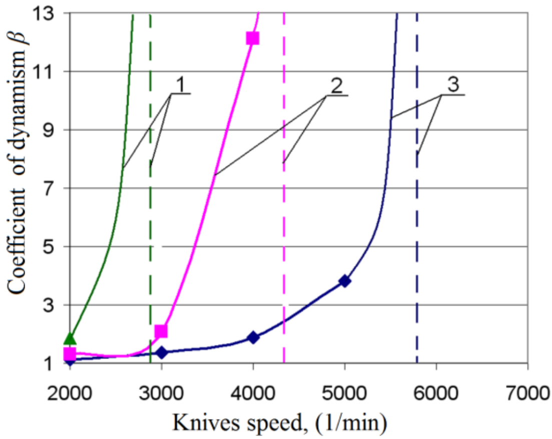


Fig. 10. Dependence of the coefficient of dynamism on the frequency of forced oscillations of the knife type I at different values of the scale factor: 1 – k = 85,7; 2 – k = 60; 3 – k = 42,9

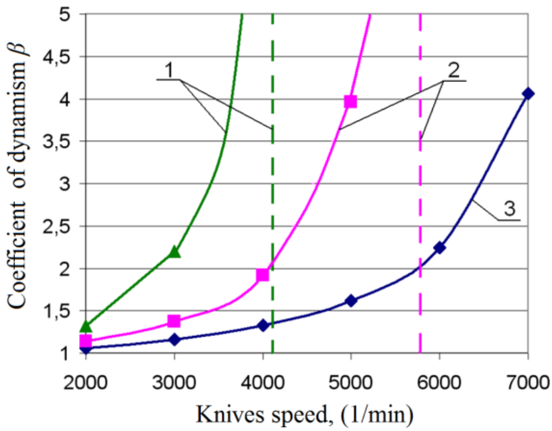


Fig. 11. Dependence of the coefficient of dynamism on the frequency of forced oscillations of the knife type II at different values of the scale factor: 1 – k = 85,7; 2 – k = 60; 3 – k = 42,9

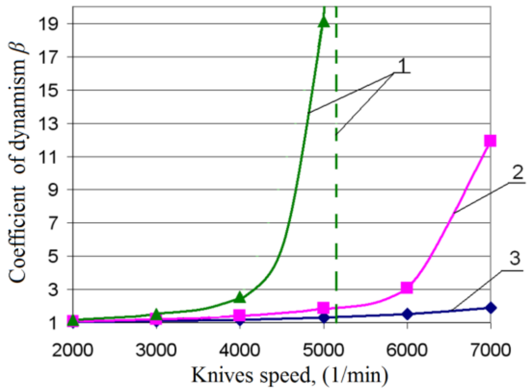


Fig. 12. Dependence of the coefficient of dynamism on the frequency of forced oscillations of the knife type III at different values of the scale factor: 1 – k = 85,7; 2 – k = 60; 3 – k = 42,9

As follows from the results, knives of all studied types when used in modern high-speed cutters work in the range of oscillation frequencies close to resonance. For knives of all types, when their minimum specific thickness (*k* = 85.7) is observed, a resonance phenomenon is observed in the range of operating frequencies of rotation of the knife heads of modern cutters (<6300 min^{-1}).

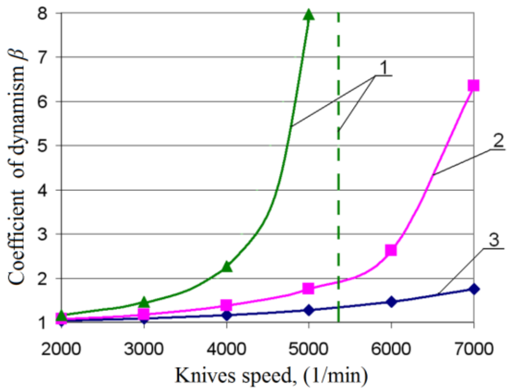


Fig. 13. Dependence of the coefficient of dynamism on the frequency of forced oscillations of the knife type IV at different values of the scale factor: 1 – k = 85,7; 2 – k = 60; 3 – k = 42,9

For type I knives, resonance is observed for all values of the scale factor *k*, and at k = 85,7 $\nu_{own.1min}$ = 2934 min^{-1}. Knives of type V, and also type VI can be considered the most rigid.

The fact is that for knives of types II-VI even at performance of their maximum specific thickness (k = 42,9) increase of coefficient of dynamism within β = 1,04-2,24 that causes essential increase in deformations and stresses can be determined for knives under static loads.

In practice, this leads to a sharp increase in stress in the areas of greatest concentration, which may explain the breakage of the knives in these areas.

The obtained results indicate the need to find effective ways to increase the vibration resistance of cutter knives, which would increase their strength without compromising technological properties.

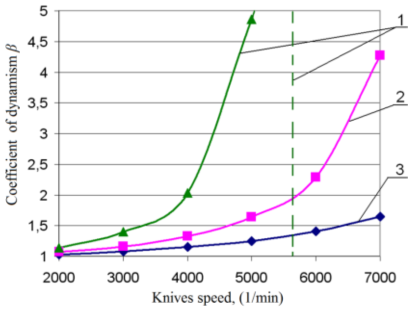


Fig. 14. Dependence of the coefficient of dynamism on the frequency of forced oscillations of the knife type V at different values of the scale factor: 1 – k = 85,7; 2 – k = 60; 3 – k = 42,9

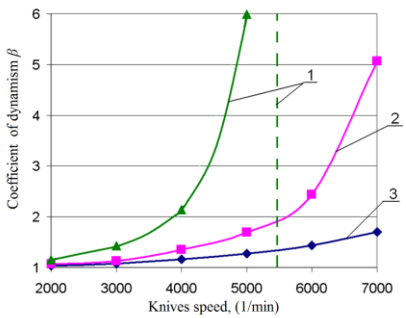


Fig. 15. Dependence of the coefficient of dynamism on the frequency of forced oscillations of the knife type VI at different values of the scale factor: 1 – k = 85,7; 2 – k = 60; 3 – k = 42,9

Table 3

The value of the coefficient of dynamism *β*

Frequency of rotation of knives n_n, min.$^{-1}$	The type of knife								
	I			II			III		
	Scale factor k			Scale factor k			Scale factor k		
	42,9	60	85,7	42,9	60	85,7	42,9	60	85,7
2000	1,13	1,30	1,87	1,06	1,14	1,32	1,04	1,08	1,18
3000	1,36	2,07	-	1,16	1,37	2,20	1,09	1,20	1,52
4000	1,89	12,12	-	1,33	1,92	33,0	1,18	1,43	2,54
5000	3,82	-	-	1,62	3,96	-	1,32	1,88	19,14
6000	-	-	-	2,24	-	-	1,53	3,06	-
7000	-	-	-	4,06	-	-	1,89	11,9	-
Frequency of rotation of knives n_n, min.$^{-1}$	The type of knife								
	IV			V			VI		
	Scale factor k			Scale factor k			Scale factor k		
	42,9	60	85,7	42,9	60	85,7	42,9	60	85,7
2000	1,04	1,07	1,16	1,03	1,07	1,14	1,03	1,07	1,15
3000	1,09	1,18	1,46	1,08	1,16	1,4	1,08	1,17	1,43
4000	1,16	1,38	2,27	1,15	1,33	2,03	1,16	1,35	2,14
5000	1,28	1,75	7,98	1,25	1,64	4,86	1,27	1,69	5,99
6000	1,47	2,62	-	1,41	2,29	-	1,44	2,44	-
7000	1,76	6,35	-	1,65	4,27	-	1,70	5,07	-

3. Stress-strain State of Knives under Static Load

The study of the static strength of the cutter blades was carried out using numerical simulations. The data given in item 1 were used to determine the forces acting on the blade and on the side of the cutter blades of Alpina, Seydelmann, Kilia, Laska, Л5 – ФКБ brands.

Stress determination was performed for two points, which are located in the most intense parts of the knife (Fig. 16). The simulation results for the Alpina knife are shown in Fig. 17 (for other knives, the dependence of stresses on the thickness of the knife has a similar linear character). Visualization of simulation results is shown in Fig. 18-22.

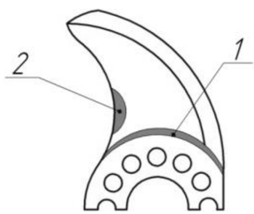


Fig. 16. Layout of the most tense areas of the cutter knife: 1 – area near the landing part of the knife, 2 – area on the back of the knife

As follows from the data obtained, the dependence of the stresses in the cutter blade on its thickness is linear for both of these points. This allows you to count on the possibility of simply increasing the strength of the knives by increasing their thickness.

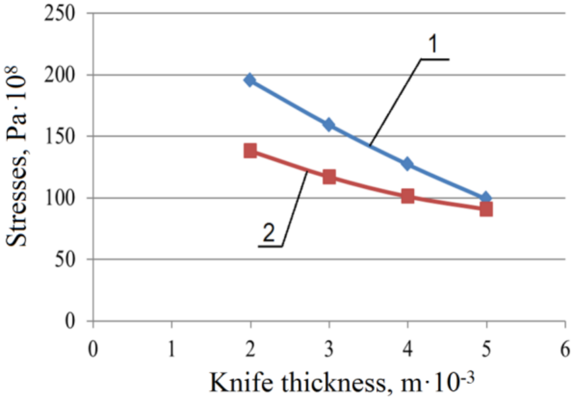
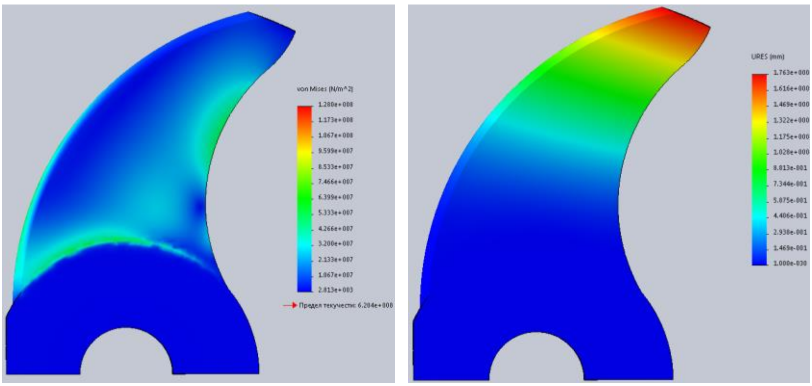
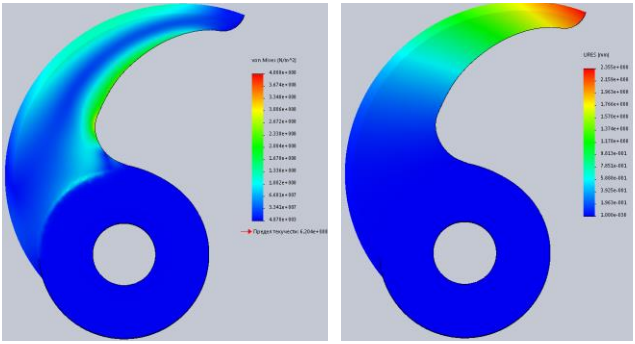


Fig. 17. Dependence of stresses in the knife of the cutter brand Alpina on its thickness: 1 – the area near the landing part of the knife, 2 – the area on the back of the knife



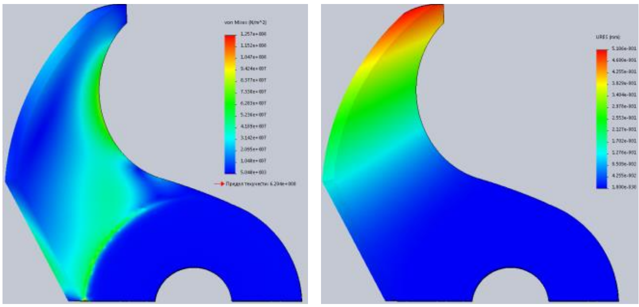
a) b)

Fig. 18. Visualization of the stress-strain state of the knives of the cutter brand Alpina: a) stress, PA; b) deformation, m·10^{-3}



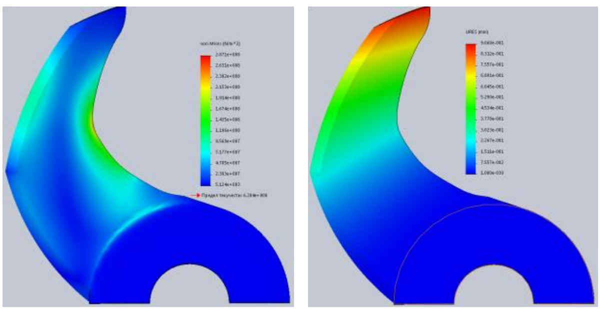
a) b)

Fig. 19. Visualization of the stress-strain state of the knives of the cutter brand Seydelmann: a) stress, PA; b) deformation, m·10^{-3}



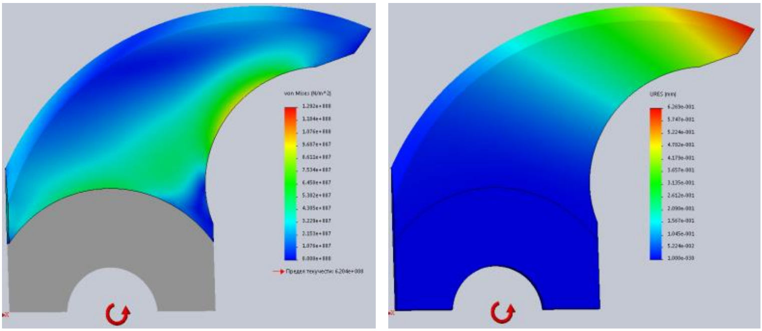
a) b)

Fig. 20. Visualization of the stress-strain state of the knives of the cutter brand Kilia:a) stress, PA; b) deformation, m·10^{-3}



a) b)

Fig. 21. Visualization of the stress-strain state of the knives of the cutter brand Laska: a) stress, PA; b) deformation, m·10^{-3}



a) b)

Fig. 22. Visualization of the stress-strain state of the knives of the cutter brand Л5-ФКБ:a) stress, PA; b) deformation, m·10^{-3}

4. Influence of Surface Hardening Technologies on the Endurance Limit of 65Г Steel

An experimental study of the fatigue strength of samples has been made by the technology of making cutter knives, as well as samples have been hardened by pulse-plasma treatment and high-frequency mechanical forging. The results obtained are presented in Fig. 23.

According the results, high-frequency mechanical forging can increase the fatigue strength of 65Г steel up to 2,5 times. At the same time, pulse-plasma hardening reduces fatigue endurance by 3-3,5 times.

5. The Influence of the Design of the Cutter Knives on their Endurance Limit

In order to study the influence of the geometric shape of the cutter knife on its resistance to fatigue failure and to develop recommendations for rational design of knives, numerical modeling of their endurance under alternating loads has been conducted. The results are shown in Fig. 24-26. As follows from the results, the geometric shape significantly affects the durability of the cutter blades at alternating loads.

The following values of endurance limit were shown by the following knives: Laska universal – $2{,}2 \cdot 10^4$ cycles; Laska for smoked sausages – $2{,}2 \cdot 10^4$ cycles; Seydelmann – $2{,}4 \cdot 10^4$ cycles. Knives of other brands have much higher durability: Alpina – $4{,}2 \cdot 10^5$cycles; Kilia – $1 \cdot 10^6$ cycles and above; L5-FCB – $1 \cdot 10^6$ cycles and above. At the same time, on average, the knives of modern cutters before disposal can work up to $2{,}3 \cdot 10^6$ cycles.

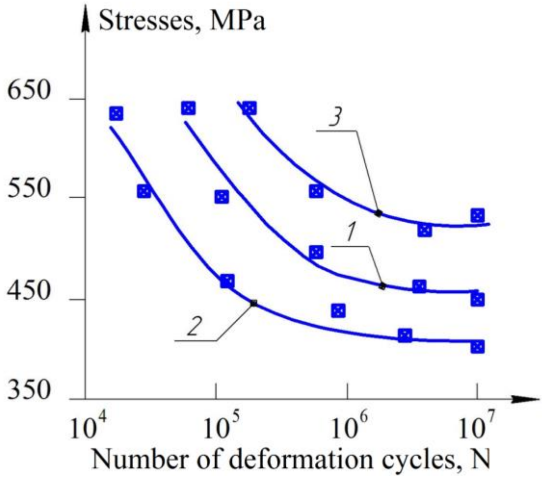
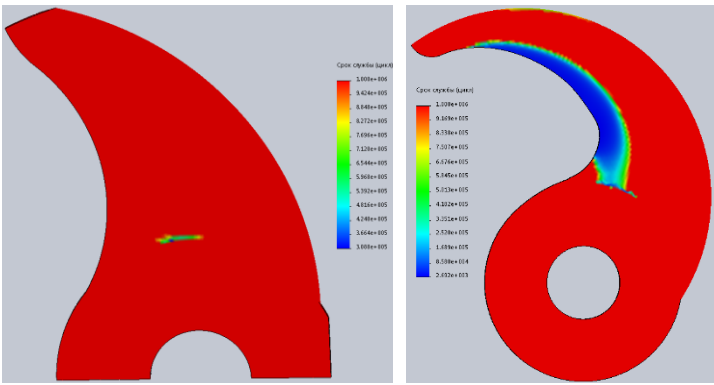
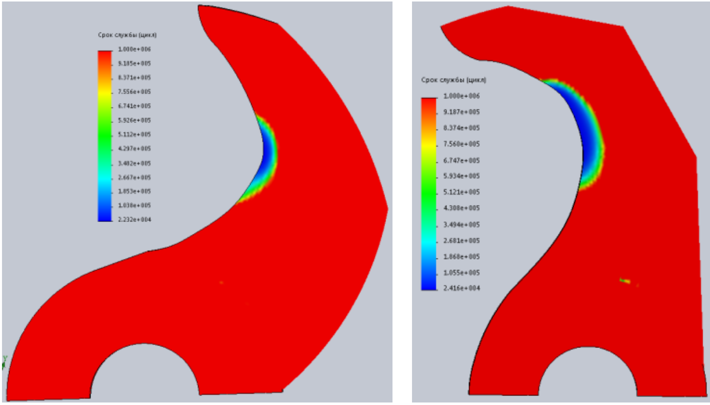


Fig. 23. Curves of fatigue of samples from steel 65:
1 – ordinary sample; 2 – strengthened by pulse-plasma treatment;
3 – reinforced by high-frequency mechanical forging



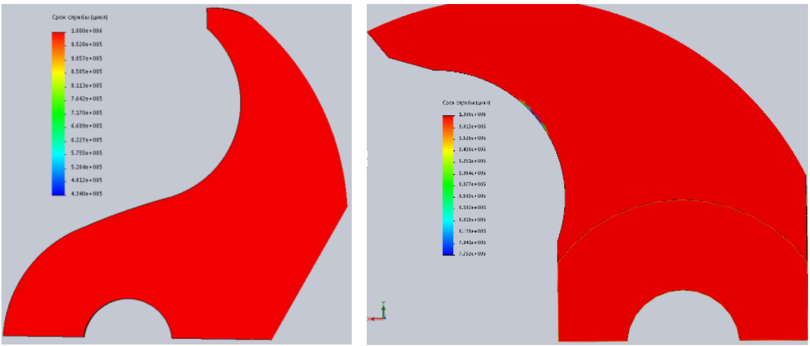
a) b)

Fig. 24. Results of numerical simulation of the durability of cutter knives at alternating loads (number of load cycles before failure):
a) Alpina knife; b) a knife of the Seydelmann brand



a) b)

Fig. 25. Results of numerical simulation of the durability of cutter knives at alternating loads (number of load cycles before failure): a) Laska universal knife; b) Laska brand for smoked sausages



a) b)

Fig. 26. Results of numerical simulation of the durability of cutter knives at alternating loads (number of load cycles before failure): a) Kilia knife; b) Л5 – ФКБ knife.

Thus, we can conclude that to ensure high endurance of knives when working on fatigue, it is advisable to perform a knife body of increased width and avoid the presence of sharp transitions of geometry to eliminate stress concentrators. It will be useful to increase the thickness of the knife in the most stressful parts of its body.

CONCLUSIONS

Numerical simulations have revealed the values of the pressures acting on the cutter blades under different operating conditions. The regularities of the influence of the blade sharpening angle, cutting speed and dynamic viscosity of the raw material on the pressure acting on the surface of the knife blade have been established. At a flow rate of 50 m/s, changing the angle β from 2° to 14° results in a change in blade pressure from 0,05 MPa to 1,37 MPa, depending on the viscosity of the raw material. At a flow rate of 200 m/s, the pressure on the blade varies from 0,69 MPa to 13,66 MPa, respectively. The obtained results allow to take into account the influence of structural and technological factors of the process on the force load on the knife and, accordingly, to increase the accuracy of the calculation of knives for strength and fatigue endurance.

By mathematical modeling using numerical methods, it has been established that cutter blades of all studied types, when used in modern high-speed machines, work in the range of oscillation frequencies close to resonant. The influence of the design parameters of knives on their resonant frequencies is found out. Quantitative characteristics of the influence of vibration loads on the stress-strain state of knives are obtained. For knives of the most common types, even when performing their design with the maximum specific thickness, there is an increase in the coefficient of dynamism in the range β = 1,04-2,24, which causes a proportional increase in deformation and stress.

The regularities of the influence of material hardening technologies andgeometrical characteristics of cutter knives on the limit of their fatigue endurance are established. The technology of high-frequency mechanical forging allows to increase the fatigue strength of 65Г steel up to 2,5 times.

Pulse-plasma hardening technology reduces fatigue endurance by 3-3,5 times. It was found that the geometric characteristics significantly affect the fatigue endurance of the known designs of cutter knives under alternating loads (Laska universal – $2.2 \cdot 10^4$ cycles; Laska for smoked sausages – $2.2 \cdot 10^4$ cycles; Seydelmann – $2.4 \cdot 10^4$ cycles, Alpina – $4.2 \cdot 10^5$ cycles, Kilia – $1 \cdot 10^6$ cycles and above, Л5-ФКБ – $1 \cdot 10^6$ cycles and above).

According to the results of research, a set of recommendations has been proposed and substantiated to increase the fatigue endurance of cutter knives, while upgrading existing and designing new equipment.

SUMMARY

The results of complex researches of influence of alternating oscillations of cutter knives on their durability and endurance are presented. The regularities of the influence of the blade sharpening angle, cutting speed and dynamic viscosity of the raw material on the pressure acting on the surface of the knife blade have been established. Cutter knives of all researched types at their use in modern high-speed cars work in the field of the frequencies of the fluctuations close to resonant. The influence of the design parameters of knives on their resonant frequencies is found out. The regularities of the influence of material hardening technologies and geometrical characteristics of cutter knives on the limit of their fatigue endurance are established. The technology of high-frequency mechanical forging allows to increase the fatigue strength of steel 65Г up to 2,5 times. Pulse-plasma hardening technology reduces fatigue endurance by 3-3,5 times. Geometric characteristics significantly affect the fatigue endurance of the known designs of cutter knives under alternating loads. The obtained results allow to determine effective ways to increase the durability of cutter blades.

Information about the author:
Batrachenko Oleksandr Viktorovych,
Doctor of Engineering,
Associate Professor at the Department of Design of Food Production and Machines of New Generation
Cherkasy State Technological University
460, Shevchenko Boulevard, Cherkasy, 18006, Ukraine,