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The Influence of the Cutting Edges of Plate Knives on the Effectiveness of the Work during Cutting of Food Products

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ABSTRACT: The article discusses the problems of improving the performance of plate knives for such indicators as cutting ability and blade durability. Improving the quality of work and the use of rational geometric parameters of the cutting tool.

KEYWORDS: edgeblade, a microrelief, sharpening, microgeometry, the lamellar knife, a cutting edge, a thickness of an edge, hardness, roughness of a cutting edge, a microtooth.

I.INTRODUCTION

The food industry should develop on the basis of accelerating scientific and technological progress in the industry, optimizing the consumption and production of food products, strengthening the interaction of food and agricultural enterprises, improving production efficiency in market conditions, improving the structural and investment policy of Uzbekistan.

When processing food raw materials and semi-finished products, one of the most common technological operations is cutting. Food materials are characterized by a complex set of technological, structural,mechanical and adhesive characteristics, so the degree of technical perfection of cutting equipment and tools largely determines the quality, appearance and yield of the finished product. Currently, for cutting food and semi-finished products used a variety of machine designs, different structure of the working cycle, the type and trajectory of the knives, the method of feeding raw materials and other features[1].

II. SIGNIFICANCE OF THE SYSTEM

Semi-finished product obtained by cutting, must meet certain requirements for the accuracy of shape, size, smoothness of the cut. The main factors contributing to the improvement of quality performance of cutting machines are: optimal cutting conditions and geometry of the knives, their high cutting capacity, the accuracy of the position and movement of the cutting and feeding working bodies in the process of work, adjustment and sharpening, special preparation of semi-finished products to reduce cutting forces, crumbling and deformation of semi-finished products[2].

III. LITERATURE SURVEY

The use of rational geometric parameters of the cutting tool, reduces the mechanical impact on the semi-finished product.

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Improving the quality of the cutting tool should be aimed at solving the problem of improving the performance of knives on such basic indicators as cutting ability, durability and stability. Very promising finding rational ways and modes of preparation of the cutting tool to work.

For the manufacture of knives, carbon and low – alloy steels of eutectoid and hypereutectoid class (carbon content – 0,8-1,2 %) with alloying additions of chromium (1,0 %) and vanadium (1,0%) are used. Such knives have, as the experience of food enterprises, sufficient resistance at a relatively low cost of the workpiece material[3].

The quality of the working area of the sliding cutting knives can be characterized by two groups of parameters:

1. Geometric (angle of sharpening, straightness of the blade, etc.) and microgeometric parameters (blade thickness, height and pitch of the micro teeth).

2. Parameters characterizing physical and mechanical properties of surface layers.

Common to all types of knives is its the cutting side (blade) is made in the form of a single-sided or double-sided wedge(Fig.1).

The face of the one-sided wedge, based in the cutting process on the main part of the product, is called the support and coincides with the plane of the knife movement.

The line, which is the pulling away of the cut portion of the product, called working.

The line of intersection of the reference and the working face is called the cutting edge of the blade.

The angle α between the reference and the working faces of the grinding angle of the blade.

The two-sided wedge has two working faces, and the sharpening angle is formed by two working faces and is 2α.

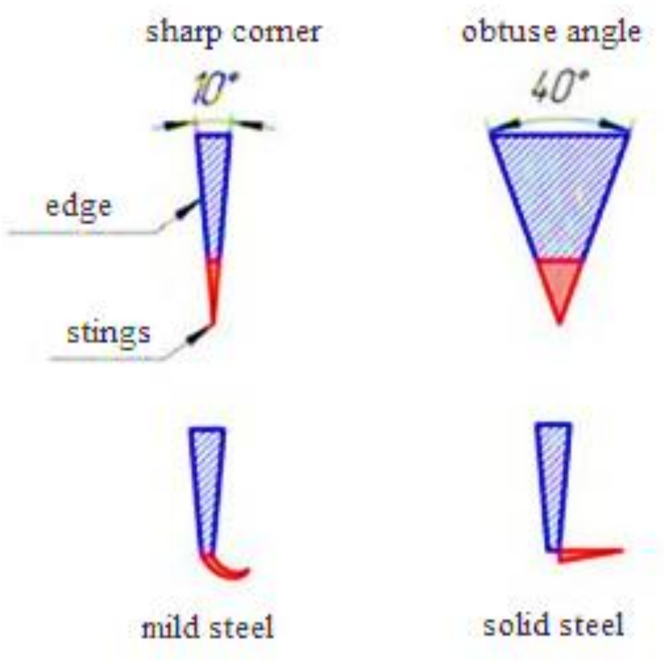

Fig.1. Knife blade angles

Knives are of different types and can be made of different types of steel. They are intended for cutting various products. Despite the fact that they are different in shape and composition of steel, all of them from time to time require sharpening. If you do not sharpen knives during prolonged use, their blade will eventually cease to perform its functions. To work with a dull blade you have to put in more effort, and there is more likely to get hurt. To the blade was quite sharp and not spoiled, you need to know the rules of sharpening [4].

Changing the geometry of the tool during operation leads to the loss of cutting properties. Tool life before blunting, i.e. between two regrinding, is called tool life. It is believed that the total resistance time consists of the time

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of two main periods: the initial, or burnishing period, when local breaks or bends of the blade can occur, and the second (often the main) period, which is characterized by gradual wear of the cutting elements of the tool[5].

IV. METHODOLOGY

Tool life depends on the cutting mode, the material to be processed, the type of tool and its material, as well as the value of the sharpening angle and the front angle provided by the tool design.

The process of blunting the cutter is to increase the radius of curvature of the cutting edge; at the same time may vary and the type of blunt curve— micro geometry. The most typical micro geometry of the cutting edge and the nature of its changes in the process of blunting knives.

Consider the process of forming the cutting edge when grinding chamfers in several passes with the running direction of the abrasive wheel (Fig.2). In the initial stage of sharpening, the blade 1 of the tool is fed to the grinding wheel 2, while the chamfer 3 of the blade 1 is ground by the periphery of the circle 2. When grinding the chamfer 3, a deformed surface layer 4 is formed, and when the edge 5 of the blade 1 descends from the periphery of the circle 2, a micro-tooth 6 with a height l_1 is formed, which is the exit of the surface layer 4 to the edge 5.

As a result, the initial width t_1 of the edge 5 in section C – C is reduced to the value t_2 (Fig.2.a) In the same way the opposite chamfer 7 is polished. As a result, a deformed surface layer 8, a microtubule 9 with a height of l_2, a gap 10 between the microtubules 6 and 9 is formed.

The edge width 5 in section C – C decreases from t_2 to t_3 (Fig. 2.b) With further processing of the opposite chamfer 4, a deformed layer 11, a microtubule 12 with a height of l_3, is formed.

The width of the edge 5 in the cross section C – C decreases from t_3 to t_4, decreases also the size of the gap 10 (Fig.2.c) When grinding the chamfer 8, a deformed surface layer 13 and a micro-tooth 14 of l_4 height are formed. The microdent 14 is combined, i.e. consisting of layers 11 and 13, and the gap 10 disappears. The thickness of the section C–C decreases from t_4 to t_5.

The convergence of the deformed surface layers 8 and 11 is accompanied by the formation of a boundary dividing line in the section C – C.

Microtube 14 is bent somewhat in the direction of the chamfer 11, the opposite end of the circle 2, in the position of the last grinding pass. The thickness S of the butt boundary dividing line is directly dependent on the thickness of the micro-tooth and the width of the cutting edge a. Fig.1.a – d shows the width parameters of the edge a_1, a_2, a_3. At the last grinding pass, the micro-tooth 14 is separated from the blade 1 by the radial component of the grinding force, and a cutting edge of width a is formed.

Considered microtube are technological irregularities sharpening (Burr). After breaking technological microsource (Burr) in the last passage on the blade there is reason mikrotubul generally lesser height and arranged with a certain longitudinal pitch. From this scheme, in particular, it can be seen that the transverse step of the micro-teeth is characteristic of insufficiently thorough sharpening of the blade (Fig.2.c)

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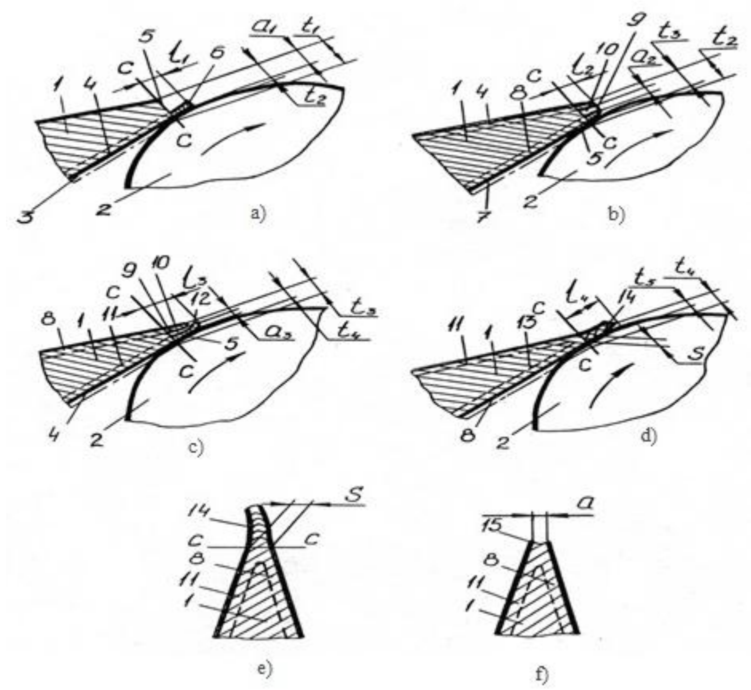

Fig. 2. Formation of the cutting edge in multi-pass grinding chamfers blade

V. EXPERIMENTAL RESULTS

When describing the parameters of the transverse and longitudinal microrelief of the blades, СТСЭВ 638-77, СТСЭВ 1166-78 and ГОСТ 2789-73 were used. In accordance with these regulatory materials for the high-altitude parameters related (Fig.3):

Ra – arithmetical mean deviation of the profile

$$R_a \approx \frac{1}{n}\sum_{i-1}^{n}|y_i|; \qquad (1)$$

Where: *n* - is the number of ordinates of irregularities;

y_i - is a single value of the ordinate of the irregularities;

Rz– the height of the profile irregularities at ten points, i.e. the average distance between the five highest and five lowest points of the measured profile within the base length:

$$R_z = \frac{1}{5}\left(\sum_{i=1}^{5}|H_{i\max}| - \sum_{i=1}^{5}|H_{i\min}|\right); \ (2)$$

where: $H_{i\,max}$ – ordinates of the five highest points of the profile;

$H_{i\,min}$ – ordinates of the five lowest points of the profile;

R_{max}– the maximum height of roughness profile, i.e. the distance between the lines of the projections and lines of the depressions of the profile within the evaluation length

$$R_{max} = |H_{i\,max}| + |H_{i\,min}|, \qquad (3)$$

where: $H_{i\,max}$ - is the distance from the midline to the profile ledge line;

$H_{i\,min}$ – distance from the middle line to the profile depression line.

The step parameters include:

S - is the average step of profile irregularities along the vertices within the base length:

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$$S = \frac{1}{n}\sum_{i=1}^{n} S_i; \qquad (4)$$

where: n - is the number of unit steps;

S_i – unit values of the vertex step;

S_m- is the average step of profile irregularities along the middle line, i.e. the arithmetic mean of the step of profile irregularities along the middle line within the base length:

$$S_m = \frac{1}{n}\sum_{i=1}^{n} S_{mi}; \qquad (5)$$

where: S_{mi} – a single value of the step on the middle line.

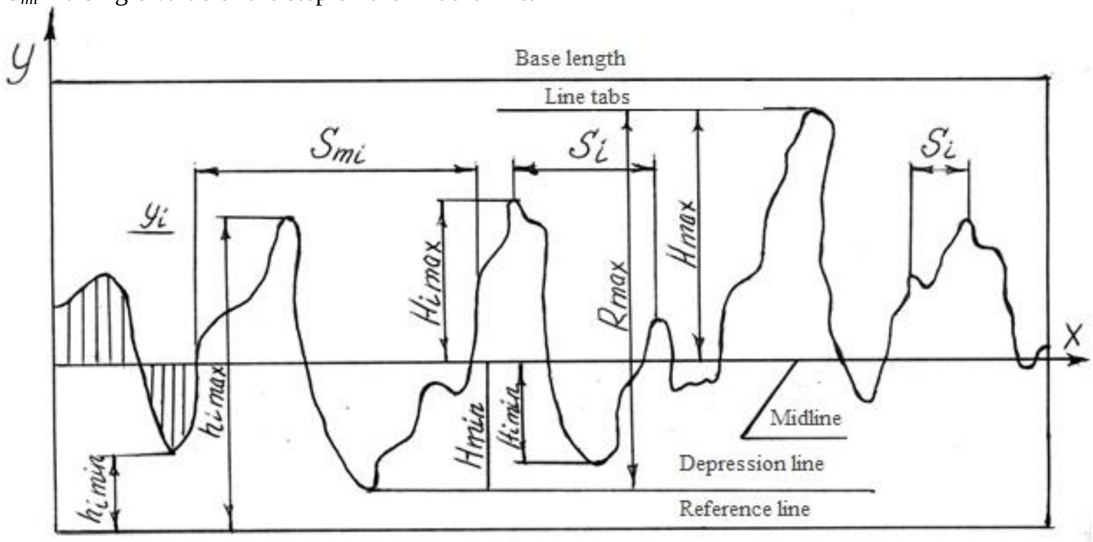

Fig. 3. The longitudinal relief of the cutting edge.

The structure of the surface layers of the polished part is shown in Fig.4. Boundary layer 1 thickness 2 – 3 ^{0}A consists of an adsorbed gas film, which can be removed only by heating the parts in vacuum. Layer 2 thickness 2-80 ^{0}A – loose deformed layer of oxides, nitrides and metal, decarbonized by high temperatures, developing during grinding. Layer 3 with a thickness of about 5 microns (in abrasive grinding) consists of highly deformed metal particles, as well as structurally free cementite released under high temperatures. Layer 4 is an undeformed metal.

Existing now in practice methods of forming the cutting edge of thin plate knives create initial parameters of microgeometry far from optimal. This leads to the fact that the entire period of resistance or a significant part of the tool works in the mode of working wear, characterized by intensive dyeing of individual sections of the cutting edge and abrasion of the working surfaces of the tool.

Reduction of brittle and fatigue chipping, as well as the intensity of abrasion can be achieved primarily by improving the quality of sharpening and debugging, which allows reducing the roughness of the active contour of the blade and, as a consequence, reducing the coefficient of influence of stress concentration and providing a roughness close to equilibrium.

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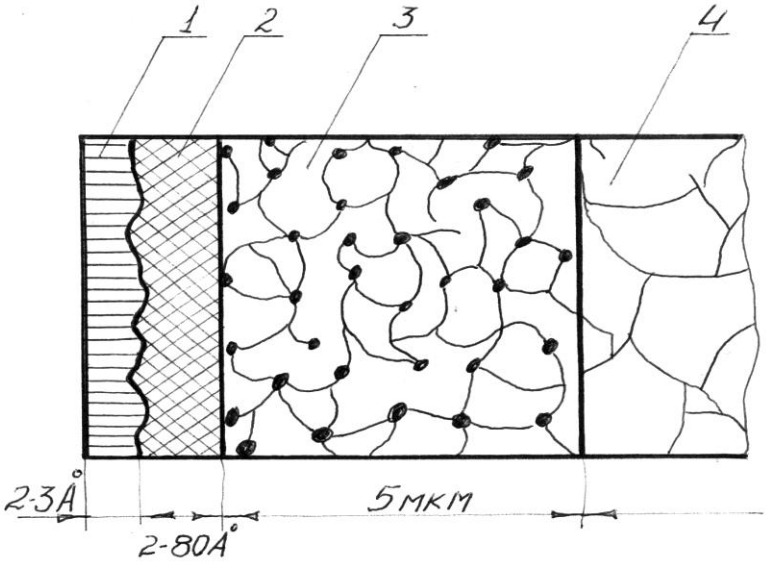

Fig.4. The structure of the surface layer of the knife chamfer

The following quality indicators are available for inspection in production conditions: the angle of sharpening, uniformity of width, straightness of the cutting edge, depth of cut, no cracks on the cutting edge, sharpness of knives.

The angle of sharpening is measured by a protractor of any design with an accuracy of 1°. Not straightness of the cutting edge is manifested in the form of concavity, convexity and undulation. When you control the straightness of the knife edge is applied to the control line probe and measure the largest gap.

VI.CONCLUSION

Check sharpened knives — a necessary condition for timely elimination of shortcomings in sharpening and debugging, further improve their quality, as well as a means of monitoring the condition of the knife-making machine. The frequency of inspection depends on the specific conditions of production and setting of sharpening business.

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