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TUNING AND SOLIDITY OF BLADES FOR CUTTING FOOD MATERIALS

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ABSTRACT

Information about raising productivity of work of cutting machines and stability of cutting tools in the result of proper organization of the process of macro- and microgeometric sharpening parameters of the edge of the cutting tools is given in the article.

Keywords: cutting tools, edge, wearing, durability, macro- and microgeometric sharpening parameters, grinding, microtooth, sharpening, hardness.

В статье приводятся сведения о повышении эффективности работы режущих машин и стойкость режущих инструментов в результате правильной организации процесса макро - и микрогеометрических параметров заточки лезвия режущих инструментов.

Ключевые слова: режущий инструмент, лезвия, износ, стойкость, макро и микрогеометрические параметры, микрозубец, шлифование, заточка, доводка, предел выносливости, устойчивость, жёсткость.

INTRODUCTION

As it is widely known, technical progress in mechanical engineering is inextricably linked with the development of machine-consuming branches of the national economy. The processing industry is undergoing a period of continuous development: the volume of products is growing, new types of food products are appearing, progressive technological schemes based on waste-free processing of raw materials are being developed, production processes are intensified, complex mechanized and automated production lines are being introduced. Accordingly, the requirements increase, which work as the main indicators of the operation, the productivity, reliability and the degree of automation of food machines and apparatuses.

In the bakery and macaroni industries, various designs of machines are used for cutting products and semi-finished products, differing in technological purpose, type and trajectory of movement of working bodies, structure of the production cycle, method of feeding products and other features. The technical level of the cutting equipment largely determines the technical and economic performance of the enterprise.

MAIN BODY

Cutting - a technological process of processing by separating a material with a violation of its integrity, carried out by a cutting tool in order to give the material a given shape, size and surface quality. For food, cutting should be done without waste.

The physical foundations of cutting food materials are quite complex and they cannot be understood based on the existing ideas about the destruction of the material as a result of its crushing by the cutting edge of the tool.

Cutting food materials is studied mainly from the standpoint of establishing empirical dependences of the main parameters of the process (productivity, energy consumption, amount of waste, etc.) on factors caused by the type of material being cut, the processing mode and the cutting tool. This direction of research is important, as it allows an objective approach to the selection of rational cutting modes, characteristics of an essential cutting tool, as well as design parameters of cutting machines within the studied area of the factor space. However, the available empirical dependencies do not always give a satisfactory solution in terms of radical improvement of the cutting process, without sufficiently revealing the features of the interaction of the blade with the material being cut, the mechanism of destruction and the phenomena that contribute to it.

In sliding cutting, the blade micro-teeth are the main element contributing to the formation of new surfaces [1,2]. The location of the micro-teeth on the blade and their shape predetermine the cutting and durability properties of the knives and depend primarily on the steel grade, its microstructure, sharpening modes, characteristics of the abrasive tool, etc. [3,4,5,6,7,8].

The operational reliability of knives largely depends on the wear durability of the material to manufacture the cutting tool, and it is determined by the retention of its cutting ability for a certain time - the period of durability.

Durability is the most important operational characteristic of knives, which significantly affects the performance of cutting machines, the consumption of tool materials, the laboriousness of preparing the knives for work and their resource. The durability of knives depends on the intensity of wear of the cutting edge, which is accompanied by complex irreversible phenomena in a thin surface layer.

The dominant role in this process is played by the change in the micro-geometric characteristics of the cutting tool. Since the parameters of the macro and micro-geometry of the blades are formed during the sharpening of the tool, and then change their value during operation, the conditions for sharpening the knives were varied in the research and the change in the studied parameters during operation was controlled.

The design features of a thin blade (6… .25 μm) significantly impede heat removal during sharpening, which can lead to a change in the metal structure. The lack of reliable fixation of the hacksaw during sharpening, the wrong choice of the grinding wheel, the forced sharpening mode, the lack of control of the hardness of the hacksaw material leads to defects in the cutting edge, in turn, to a decrease in the cutting properties and durability of the hacksaw.

The object of the study was knife plates (δ = 0.4 mm) made of У8A steel, heat treated for a hardness of 46 - 48 HRc. The double-sided sharpening angle was 150. Sharpening was carried out on a machine which model was ZG71 with a circle E8 40SM26K without coolant with the dressing of the circle with a diamond pencil of type C. Lapping (fine-tuning) of the chamfers was carried out with leather wheels using GOI polishing paste. The initial parameters of sharpening were: grinding speed - 30 m / s, work piece movement speed - 6 m / s, grinding depth - 0.01 mm.

To describe the transverse and longitudinal micro-relief of the blades, the following parameters were used: a is the width of the cutting edge, Ra is the arithmetic mean deviation of the profile, Rp is the height of irregularities at 10 points, Rmax is the maximum height of irregularities, Sm - the longitudinal pitch of irregularities along the center line, Sn - the transverse pitch of the irregularities, b and v are the indices of the support curve, γ is the angle of inclination of the irregularities.

In the experiments, a measuring complex was used, which included a scanning electron microscope, a microcomputer, and an interface unit.

The results of measuring the parameters of the microgeometry of the lamellar knives are presented in Table 1.

This data is an arithmetic mean value and is characterized by the coefficients of variation: for parameters a, Ra, Rp, Rmax, Sn - 10 - 12%, for Sm, γ - 15 - 20%. The samples indicated in the first column (see Table 1) were obtained under the following conditions:

1 - chamfer of a knife sharpened under the modes mentioned above;

2 - blade of the same sample;

3 - blade, sharpening and finishing along one edge;

4 - blade, sharpening and finishing on two edges;

5 - type 1 sharpening after 4 hours of knife operation in the AG - 3 grinder;

6 - type 1 sharpening after 48 hours of operation;

7 - sharpening and fine-tuning according to type 4 after 48 hours of work.

Table 1 Microgeometric parameters of blade knives

N\N	a, μm	R_a, μm	R_p, μm	R_{max}, μm	S_n, μm	S_m, μm	B	v	γ
1	-	2,3	4,3	9,2	-	16,3	2,3	1,8	40
2	18,3	7,9	11,8	23,2	11,2	79,1	2,5	3,2	42
3	12,9	5,6	9,3	19,8	7,1	115,1	1,8	3,0	40
4	4,6	3,2	4,7	12,4	2,8	175,8	-0,5	5,4	38
5	21,6	5,8	11,0	24,3	10,4	263,2	2,0	1,8	53
6	31,3	12,2	19,5	29,0	17,3	721,0	1,8	2,2	69
7	14,3	5,3	10,0	21,7	7,9	380,0	-0,3	9,1	48
* For the finished blades, the values of the coefficients of the straight section of the reference curve K and C are shown.									

Sharpening without fine-tuning gives the width of the cutting edge (a) and the transverse step (Sn) several times greater than that of a blade brought along two edges. There is a one-to-one correspondence between these values when varying the modes of blade formation and the duration (T) of the knives. The same can be stated with regard to the group of altitude parameters.

The height of the micro-teeth (Rmax) on the blade is 2 - 2.5 times higher than on the chamfer. This is due to the imposition of two lateral micro-reliefs on the blade, which are formed separately when grinding the chamfers. After a running-in period and a decrease in altitude parameters during further operation of the knife (T> 0), the value of Rmax additionally increases by 15 - 40%.

The length of the longitudinal step (Sm) of the microroughness of the blade is an order of magnitude higher than the value of Sn. On the other hand, Sm on the chamfer is 5 - 8 times less than on the cutting edge. The use of finishing along one and two bevels increases Sm. During the operation of knives, Sm increases, this growth is especially noticeable (almost 10 times) for knives sharpened without finishing (sample 1).

Fine-tuning significantly changes the shape of the reference curve of the blade, on which there is practically no curvilinear section. In the straight section, the dependences $\eta = f(\varepsilon)$ for the adjusted blades are located higher, which provides a large contact area with the same approach. The coefficients b and v of the bearing surface curve vary over a wide range. The angle γ at the apex for sharpened and finished blades is, as a rule, less than 450, and for blades that have worked for 48 hours, more than 450.

A consistent decrease in the roughness of the cutting edge is shown when finishing on one and two edges (see Table 1). So, after finishing on two edges, the height parameters of the cutting edge are reduced by 1.8 - 2 times. The rest of the parameters depend on fine-tuning to a much lesser extent. Lapping on two edges provides the sharpest blade (a = 4.6 μm) and the smallest transverse pitch (Sn).

The shaping of the cutting edge occurs due to the intersection of the micro-reliefs of the side surfaces, and the micro-geometry indicators are influenced not only by the sharpening modes, the material's physical and mechanical properties, but also by the forces and directions of grinding. At the initial stage of the operation of the knives, there is an intensive change in the irregularities obtained during the processing of chamfers with an abrasive tool, their crushing and plastic deformation. In this case, the protruding micro-teeth are destroyed and new ones are formed, different from the original ones in shape and size. The period of normal operation of the knives corresponds to the process of stationary wear and is characterized by a relatively low rate of change in the parameters of micro-geometry. A reduction in the running-in period and an increase in the service life of the knives is facilitated by the finishing of the blades.

CONCLUSION

The research results are used in the development of knives in order to increase the cutting ability for cutting slab bread in the production of zwiebacks and for cutting raw pasta(or macaroni) in the production lines for short-cut and long-tube products. Tests of cutting tools at a number of food enterprises in the city of Tashkent and Bukhara have shown the possibility of a dramatic decline in the amount of waste and rejects during cutting, a 6 - 8-fold increase in the durability of knives.

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