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# DEVELOPMENT OF TECHNOLOGICAL REGULATIONS FOR MANUFACTURING PLATE KNIVES USING A PILOT PLANT

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**Abstract:** The article deals with the complete technological procedure for the manufacture of knives, developed on the basis of an analysis of the results of laboratory studies of the process of cutting food materials with cutting plates of various configurations, as well as an installation for the preparation of thin plate knives.

**Keywords:** sharpening, cutting edge, knife holder, grinding wheel, grain size, blade microgeometry, durability, pilot plant.

## Introduction

Sharpening of lamellar knives at food enterprises, as a rule, is done manually on emery sharpeners, the grinding wheel of which has a coarse grain size (30 - 40). The sharpening operation is carried out by insufficiently qualified personnel, which leads to the formation of defects in the cutting edge. First of all, the specified sharpening angle is not maintained. In addition, the cutting edge is not straight enough and has turns of the blade sections, notches, and bluing. This affects the duration of the operation of the knives (the period of durability and the resource of the cutting tool), the quality indicators of the operation of the cutting machines. So, for example, as production data show, the period of durability of plate knives for cutting rusks with a holding time of 6-24 hours is 3-4 hours. [1,3,4]

The operation of restoring the cutting properties of knives depends on the qualifications of the operating personnel and, on average, for the A2 – XP – 2П machine is 15–20 minutes for each knife. The complete set of cutting tools for this machine contains 27 lamellar knives.

The production experience of rusks enterprises shows that the existing thin blade knives used in the A2 – XP – 2П, XPO – M, P3 – XPC machines require significant tension. This reduces the durability of the working bodies, causes deformation of the fasteners. When the tension is released, lateral deflection of the cutting edge appears due to the insufficient working rigidity of the thin blade knives. The resulting wedge-shaped slices or wavy side surfaces of the workpiece make it difficult to ensure uniform drying of products, often lead to the formation of rejects in terms of the color of the side sides of the biscuit.

## Main part

The production tests involved knives made of U8 tool steel having a hardness of 44–46 HRC, with the following geometrical parameters: length l = 250 mm, blade width B = 15 mm, relative eccentricity of the tension line □ = 0.2, sharpening angle of the cutting edges a = 160, blade length l1 = 200 mm. Taking into account the peculiarities of the organization of the work of the repair services of food enterprises, the device for sharpening and finishing knives was made in the form of an easily removable unit mounted on a universal lathe. The layout of the assembly units of the experimental device for forming the blades of thin plate knives is shown in Fig. 1 a. The grinding or lapping wheel with the help of bushings and nuts is fixed on a horizontal shaft-mandrel (Fig. 1 b). one end of the shaft is mounted in a three-jaw chuck of the spindle, and the other is abutted by a rotating center. The knife holder, shown in Fig. 1c, is mounted in the tool holder of the machine. The design of the knife holder provides for a constant sharpening angle equal to 160.

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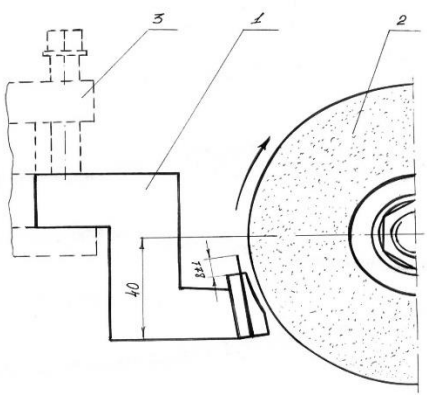


**Fig. 1a. Pilot plant for preparing thin plate knives for work**

**1 - knife holder; 2 - sharpening shaft; 3 - machine tool holder.**

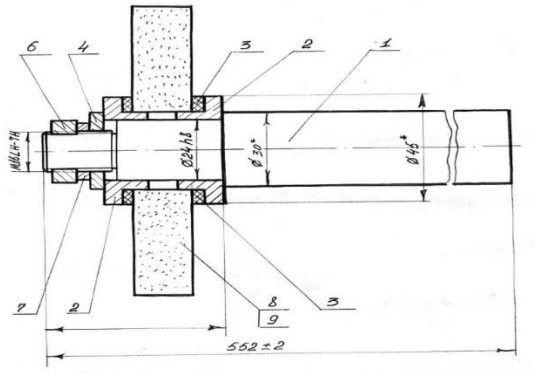


**Fig. 1b. The grinding shaft of the pilot plant.**

**1 - mandrel shaft; 2 - bushings; 3 - gaskets; 4- washer; 6 - nut M16; 7 - bushing; 8 - grinding wheel; 9 - finishing circle.**

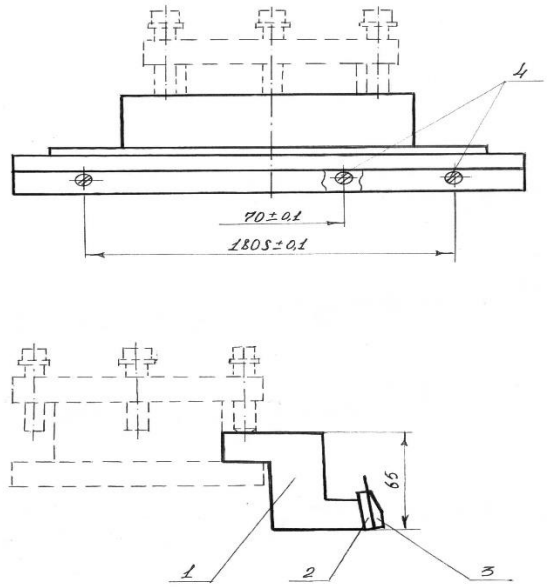


**Fig. 1c. Knife holder: 1-case; 2 – body plate; 3 – consignment plate; 4 - screws.**

The research results made it possible to recommend grinding wheels with grit 6 or 10, hardness M1 and M2 for sharpening flap knives with obligatory finishing with a leather wheel.

The use of this device made it possible to improve the quality of sharpening of plate knives, which resulted in an increase in their cutting ability and durability period, as well as to reduce manual labor in this operation and its duration, and to reduce consumption standards for materials for making knives. The knives used on this device have a predetermined sharpening angle along the entire length of the blade and have high technological reliability.

The complete technological regulations for the manufacture of knives are presented below. It was developed on the basis of analysis of the results of laboratory studies of the process of cutting food materials with cutting bodies of various configurations and tested in production conditions.

Knife parameters. Increasing the technological reliability of thin plate knives is achieved through the optimal combination of their geometric parameters and microgeometry of the blades. As the research results have shown, the geometric parameters of thin plate knives for cutting rusks should have the following values: sharpening angle –15–17$^0$, knife width –10–15 mm, thickness –0.4–0.5 mm, length 250 or 330 mm (for cutting dry plates, depending on the type of machine), a triangular notch on a blade with a depth of 2-3 mm, with a step of 10-12 mm, apex angle - 60$^0$.

The displacement of the mounting holes towards the cutting blade by 1–2 mm at the specified blade width increases the stability of the blades with reduced thickness and reduces the load on the cross members of the blade frames.

The microgeometry of the blades is determined by the thickness of the blade, the height and location of the micro-serration complex, which play the greatest role in the

cutting process. The control of these parameters in the manufacture of knives is associated with significant difficulties. Therefore, the provision of optimal parameters of microgeometry is carried out by strict adherence to the following rules for sharpening and fine-tuning of knives according to workpiece materials, brands of abrasive tools and processing modes. [2]

Blank. For the manufacture of knives, high-quality carbon or alloy steel U8-10A is used in the form of a tape with a thickness of 0.4 mm and a width of 10-15 mm. On a horizontal machine, the tape is cut into pieces equal to the length of the knives used in a particular cutting machine (for a machine of the type KhRP-250 mm, KhRO-330 mm). The right angles of the resulting workpiece are rounded on emery to a radius of 3 - 4 mm.

There should be no cracks, burrs, or traces of corrosion on the surface of the workpieces. The surface finish of the workpiece must be at least the seventh grade. Varying of blanks is not allowed. The thickness variation should not exceed 0.05 mm, and the unevenness of the workpiece width should not exceed 0.3 mm along the entire length.

Making mounting holes. On the side surface of the workpiece, the longitudinal axis of symmetry is marked using a long side face as a base. In the extreme zones of the workpiece, a displacement line is applied, spaced from the longitudinal axis by 1–2 mm (depending on the original width of the tape), towards the future cutting edge, so as to ensure its relative eccentricity  = 0.2 .To find the axes of the holes on the displacement line, it is advisable to use a template (conductor). Punching (drilling) of holes is performed using the method adopted at the enterprise.

Notching. On the long side face of the workpiece, points are marked, spaced from each other at a distance of 10-12 mm with a constant step. The location of the first point in relation to the fastening hole is indifferent. After fixing the workpiece (or a package of workpieces 8-10 pcs.) In a vice using a triangular file, a notch 2-3 mm deep with an apex angle of 600 is applied at the marked points. To perform this operation, you can use a special tool for notching files in the form of a hardened prism.

Heat treatment. Increasing the hardness of the material of a thin plated knife due to heat treatment up to HRC values of 48–52 units improves their grindability during sharpening operations and significantly increases the service life compared to knives sharpened in hardness as delivered. For heat treatment of plate knives, quenching with heating to t = 7400 C and cooling in oil is recommended. Hardness control must be carried out on a device of the PMT-3 type.

Sharpening. Sharpening and finishing operations are performed on a special device (see Fig. 1), which is mounted on any universal lathe with a center height of at least 150 mm. A flat abrasive disc of a straight profile on 2 bushings is installed between the O-rings on a sharpened shaft and fastened with an M20 nut. One end of the shaft is clamped in the chuck of the machine. On the other hand, the shaft is fixed with a taper of the tailstock. The grinding shaft is installed so that the distance between the ends of the abrasive wheel and the chuck is within 250-300 mm.

A knife holder is fixed in the tool holder of the machine so that the protruding edge of the base is parallel to the longitudinal axis of the sharpening shaft. The blank of the knife is installed and secured between the front and rear strips. After sharpening the workpiece on one side, turn it over and sharpen the other face (chamfer).

Sharpening modes: grinding wheel EB25M2K; peripheral speed - 12-15 m / s; cross feed (cutting depth) -0.04 mm; longitudinal feed - 0.6m / min. After sharpening each side, the knives are "nursed" (without cross feed) within 3-4 double strokes of the knife holder. As a result of sharpening, the knife has a sharpening angle of 16 + 10, and the width of the cutting edge is 5 - 8 microns.

Debugging (editing). Before finishing it is necessary to grease the side chamfers of the knife with "Industrial" oil. Lapping reduces the width of the cutting edge to 2-4 microns and ensures optimal topography of the blade microrelief. For finishing on the grinding shaft, a wheel made of electrocorundum with grain size 6, hardness CM2 or a grinding wheel made of elbor is installed. It is also allowed to install a circle made of electrocorundum on a ceramic bond of the same grain size and hardness. Cutting depth - 0.005 mm. The rest of the parameters do not change in comparison with the previous operation. Good results are obtained by subsequent polishing of the chamfers with a leather or felt wheel.

When sharpening and fine-tuning, it is necessary to strictly observe safety rules when performing grinding work (fencing, balancing wheels, monitoring their strength, fastening conditions, etc.).

Sharpened knives should be pre-wiped with a soft cloth, and then washed with hot water with 1-2% soda ash and wiped dry. If the knives are not placed in the knife frame, they must be preserved in the usual way.

The control. In production conditions, the quality control of sharpening and finishing of each knife is carried out by visual inspection according to the following indicators: straightness of the cutting edge; lack of twists, burrs and chipped places on the blade; no staining and no sanding cracks on the chamfer.

Installation of knives. The knives are mounted in the knife frame in the usual way. It is recommended to tension them consistently in the direction from the edges to the middle of the frame. The magnitude of the pulling force should be reduced compared to previously applied.

## Findings

Compliance with the requirements of this regulation provides an increase in the durability period of thin blade knives by several times, a reduction in cooling and holding of rusks to 0.5-1.0 hours, an improvement in cut quality, a decrease in return waste in the form of crumbs and deformed slices. The design of the machine (fastening and tension of knives, cutting and feeding modes) does not need any changes.

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