PREPARING PAPER BLOCKS FOR GLUE APPLICATION WHEN USING SEAMLESS JOINTS

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Printed products that are produced in large volumes and some of them that are not intended for long-term use are manufactured using seamless adhesive joints (КБС).

Seamless adhesive joints, however, are a rather complex production object. Gluing the spines requires a certain roughness of the paper, which ensures the penetration of glue to a depth of 1 ... 1.5 mm to connect the sheets of printed products into a single whole. An important factor is that gluing is performed on automated equipment and eliminates manual quality adjustments.

The best roughness index for seamless adhesive bonding is considered to be $200 \leq Rz \leq 600$. Before gluing, the paper block is cut from three sides using special knives as a tool on paper cutting machines, which have different cutting lengths and different degrees of mechanization. Then the block is aligned along the side opposite the spine and milled along the fourth side, which is then glued. Paper cutting knives operate at relatively low cutting speeds, therefore, tool steels are used as tool materials for their manufacture.

The main problem of their production is the quality of sharpening, which is provided at the proper level when using CBN wheels or their more modern substitutes made of Sinter korund (sintered corundum). A serious problem in printing production when using seamless adhesive joints are end mills.

The fact is that the main operation for processing spines is end milling. The choice of the method is explained by the fact that end mills are relatively easy to equip with hard alloys, do not require special installation accuracy, allow an increase in diameter dimensions, and thus a decrease in their rotation frequency, which is very important at high cutting speeds.

Seamless bindings usually have no more than 200...400 sheets, which determines their thickness in the range of 20...60 mm, which can vary depending on the thickness of the paper.

Since the roughness of the processed spine varies within significant limits, on end mills one tooth (and this is another advantage of end milling) is made more protruding (by 1... 1.2 mm) than the others, and it performs a special torsion operation, after which cuts remain on the spine surface, ensuring the gluing of the stack.

At first glance, comparing the mechanical properties of metals, as the main object of end milling, and paper, one might assume that the task of increasing durability is not relevant. The practice of printing production has proven the opposite.

Even high-quality paper contains foreign solid inclusions that act as a kind of abrasive. Their appearance in the paper is related to the technology of its production, transportation, processing, etc. Thus, counting on easing the cutting conditions and, accordingly, choosing the tool material and the geometry of the cutting wedge, we are obviously mistaken.

This task should be considered from two points of view:

- increasing the durability of the tool operating on the existing printing house equipment;
- developing the tool for newly designed equipment.

The paper milling process is specific and poorly understood. This mainly concerns the wear mechanism, the application of the advantages of oblique cutting, and the rational geometry of the cutting wedge. The situation is largely explained by the fact that the traditional view of end milling of metals is transferred to paper processing. This is largely explained by the fact that there is no theoretical model of oblique milling of paper that takes into account its special properties.

It should be noted that the quality of spine surface preparation for glue application is one of the most important factors determining the strength of seamless adhesive joints of paper blocks. Many experts believe that the quality of mechanical spine processing is one of the defining characteristics of the strength and durability of seamless adhesive joints. The quality of the processed spine surface is characterized by macro- and micro-geometry, which, in turn, is the arithmetic mean of the height of the unevenness of the sheet ends.

The quality of the milled surface of the spine depends on the parameters of mechanical processing; the gap between the block clamp and the cutter teeth, as well as the type of paper and the direction of its fibers relative to the spine of the block.

Microroughnesses, the height of which varies within significant limits, play a major role in the interaction at the glue-paper interface.

Smooth cuts of sheets (when cutting the spine of the block with a flat knife) have a small area of gluing with the adhesive film, and their micro-geometry does not ensure

good wetting and adhesion of the glue to the paper. Large irregularities and tears on the spine surface also make it difficult to wet the paper with glue, air accumulates in them, preventing contact of the glue with the paper. Applying transverse cuts and slits (torching) increases the strength of the seamless adhesive joint. In the process of torsion of the spine of the block, the surface of the ends of the sheets increases, micro-tears are formed, through which the glue penetrates to the side surfaces of the sheets. With high-quality torsion, the glue penetrates between the sheets to a depth of 0.3 ... 0.4 mm, which increases the gluing area up to 6 times compared to gluing only along the ends of the sheets. When manufacturing printed products, rolls with text printed on them are first made, then these rolls are cut into individual pages with roller knives, which are folded into paper blocks. Each such block is a semi-finished product of a single printing product - a brochure, a book, etc., the thickness of which is no more than 20...40 mm. Then, using special knives (Fig. 1), the block is trimmed on three sides.

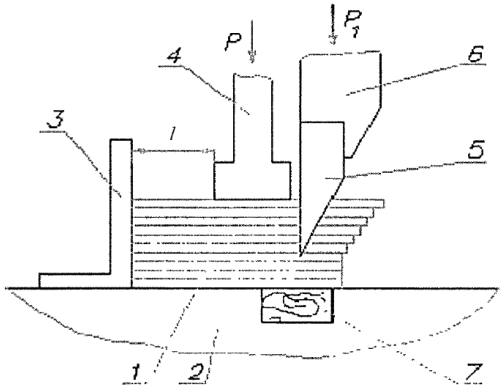

Fig. 1. Cutting sheets in the table: P - clamping force; P_1 - cutting force

Cutting sheets in a stack (block) on a paper cutting machine is performed in the following order:

- stack of paper 1 is fed to table 2 of the machine and is pressed with one so-called "true" side to feeder 3, and the other to the side square (not shown in the figure);
- before cutting, the pressure beam 4 is lowered onto the stack and presses it;
- a flat wedge-shaped knife 5, fixed in the tool holder 6,cuts the stack, pushing the cut part aside with a beveled edge, and cuts into the marzan 7, located in the groove of table 2.

Under the force action, the stack slightly moves away from feeder 3, however, the length of the cut part is even on each individual sheet, and the resulting waste does not affect the cutting accuracy.

The fourth side of the block is subjected to end milling after alignment.

The milling scheme is unusual - the cutter 3 is most often located on the vertical axis (Fig. 2), and the paper block 2, compressed by clamps 1, whose surface to be processed is located at the bottom, for ease of transportation, has a feed perpendicular to the plane of the drawing.

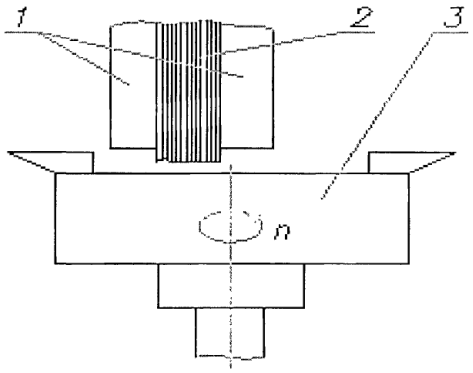

Fig. 2. End milling of paper block spines

Thus, the conducted analysis allows us to identify the following scientific tasks, the solution of which will help to solve the problem of quality and productive production of seamless adhesive joints:

- analysis of the technology of end milling of paper block spines, tool designs and tool materials in order to find the most rational cutting;
- development of a theoretical model of end milling using oblique cutting;
- performing experimental studies of the paper block milling process to determine the wear mechanism and determine the criterion for assessing durability, as well as to determine the provided roughness;
- determination of the rational geometry of the cutting elements of the cutters, taking into account the specifics of the process and the nature of wear;
- development of recommendations on end milling modes and factors ensuring the performance of this operation.