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STAGGERED TOOTH CUT-OFF MILLING CUTTER FOR STRUCTURAL MATERIALS' MACHINING

Disk cutting-off tool is widely used for cutting different materials as it can work in hard restricted conditions. It can be explained by high amount of teeth, unsatisfactory shape of chip flutes, short major cutting edge, adverse chip formation conditions, intermittent cutting procedure character, and variable over time load on the teeth, availability of the harmful vibrations with high amplitude and relatively low frequency. These are the reasons of intense wear and breakage of the tool, which results from chip being clamped in the flutes. That is why an amount of teeth, tooth profile's shape, the size of tooth and cavity have great importance for cut-off milling cutters.

There is a huge amount of different constructions of side cut-off milling cutters and each of them has its own advantages and disadvantages. By the construction of cutting head they can be divided into following groups:

– by the construction of the major cutting edge: with straight and zigzag cutting edge;

– by teeth arrangement: with uniform and irregular tooth spacing angle (milling cutters with irregular tooth spacing angle are characterized by increased dynamic stability);

– by tooth's profile: with small, medium and large teeth;

– by tooth's shape: with straight (directrix of the blade's face surface is rectilinear and perpendicular to the speed of the principal cutting movement) and multidirectional (directrix of the blade's face surface is rectilinear and inclined at an angle to the speed of the principal cutting movement of the milling cutter) teeth.

A great influence on the milling cutter's work is provided by an allowance shearing scheme. In practice, various allowance shearing schemes are used. For providing normal conditions of chip formation and its free placing in the tooth's kettle it is suitable to use group allowance shearing scheme by decreasing lengths of the active cutting edge on each tooth. Separation of wide chips for a range of sites can be achieved by changing the diametral sizes of adjacent teeth and cutting edges' shapes.

Cut-off milling cutters have cutting edges located on the periphery and have no minor cutting edges on the ends. Typically, the cutting edges are straight lines that are parallel to the axis of the milling cutter. As a result, cutting edges' inclinations are zero and the process of orthogonal cutting takes place when cutting is off.

Rake angles and clearance angles, measured in the perpendicular to the cutter's axis section, are chosen according to the exploitation condition. The clearance angle serves for reducing the friction between flank surface of the tool and cut surface.

Research shows that aimed clearance angles' value, which provides the highest hardness for tool, is determined mainly by the thickness of shear. Recommended values of clearance angles increase with narrowing of the shear. The thicknesses of shear have small values while cutting-off the workpiece with milling cutter, so the appropriate values of clearance angles may reach 30–45 degrees. When choosing the clearance angles consideration must be given to fact that with their increasing the roughness of the machined surface grows too, so, if raise demands are presented to the roughness and accuracy it is recommended to reduce the clearance angles' values to 3–10 degrees.

A great influence on the cutting process is provided by the rake angle. With the rake angle increasing the cheap formation process is enhanced, cutting forces and power, demanded for cutting process realization, are reduced. On the other side, rake angle increasing leads to heat rejection impairment, cutting part's strength decreasing, this raises the tool wear rate. As a result, an appropriate rake angles' values for certain machining conditions can be determined, taking in account an influence of variable factors.

Changing of the entering angle causes changing the proportion between the thickness of the sheared layer and cutting edge operating length, however the face surface position relative to the direction of the tool movement remains constant. The thickness of sheared layer changing is caused by changing the value of the angle of shear, direct force, frictional force and shearing force, but direction of the chip movement stays unchanged.

The angle of the main cutting edge has a special place among the geometric parameters of the cutting tool. It can be explained by its the most multiplex influence on the main characteristics of the cutting process and, above all, on the sheared layer deformation, when turning it into chip.

Variation of the major cutting edge inclination is changed by each of face surface position of the tool relative to its movement direction and proportion between cutting edge's operating length and thickness of sheared layer. Furthermore, not only operating length of the cutting edge is changed but also, in some cases, the sheared layer thickness.

Under the conditions of constrained cutting multiplex influence of the major cutting edge, inclination is boosted by constrained chip flow down the face surface, which occurs when cutting edge inclination has positive sign. Changing inclination of the cutting edge leads to changes in values of operating rake and clearance angles, which also changes conditions of the sheared layer deformation and tool's flank surface run-out.

Therefore, according to the researches of variable tool constructions with different cutting edge inclination values and signs, as well as researches of the constructions of variable milling cutters, it may be concluded, that through the change of cutting head of the cut-off cutting mill geometry and cutting edge position at an angle, we can reach reducing of vibration of the working cutting mill. It makes possible to work at higher speeds, noise reduction, to improve the quality of machining, to decrease the size of burrs on the cutting mill, to change the allowance shearing scheme, to narrow the shear cut by each tooth and to provide free chip placing in the tooth's cavity, to enhance the chip formation process through chip division by width, that will provide increasing of the cut-off milling cutter lifetime.

The research of the side cut-off milling cutters shows, that using irregular tooth spacing makes a great impact on vibration while cutting, tool durability, machining accuracy and the quality of machined surfaces.

The advantage of staggered tooth milling cutters is that total forces of cutting are reduced through the change of direction of forces, which affect every milling cutter tooth, involved in cutting process currently.

Oriented on investigation made, for cutting a workpiece of structural material it is efficient to choose staggered tooth cut-off milling cutter. The choice of actual construction is based on the fact, that comparing to straight-flute milling cutters, and milling cutters with irregular tooth spacing, staggered tooth milling cutters provide cutting forces decreasing, and the quality of machined surfaces is enhanced. Comparing to milling cutters with irregular tooth spacing, certain milling cutters are more processable, there is no need to use the set of milling cutters or special milling cutter while milling.