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AUXILIARY TOOL FOR HIGH-SPEED AND HIGH-PERFORMANCE PROCESSING

High Speed Machining (HSM) and High Performance Machining (HPM) are progressive technologies for processing structural and tool materials that reduce production time, improve product accuracy, and dramatically improve productivity. They are widely used in machine tool, automobile, aviation and other branches of mechanical engineering.

HSM technology involves increasing the speed of metal removal from the treated material only by increasing the cutting speed V, and HPM technology - mainly due to the increase of feeds S and (or) the depth of cutting t.

The advantages of the HSM and HPM are recognized in all developed countries of the world: high speed of cutting 400 - 3000 m / min, high spindle speed of 10 000 - 40 000 revolutions per minute, which helps to reduce production cycle time by 50% and more, significant increase of labor productivity, ensuring high quality of the treated surface (as with grinding).

The high interest of mechanical engineers in the prospects for the development and implementation of technologies by the HSM and the HPM is caused by the following:

1) the need for high-performance and precision machining of parts made of non-ferrous alloys, aluminum, graphite, plastics, etc., high-strength alloyed and tempered steels and alloys, alloys made of nickel, titanium, ceramic materials that are difficult to process, etc.

2) the need for high-performance and precision machining of small-size parts for high-tech machines and devices (so-called microprocessing);

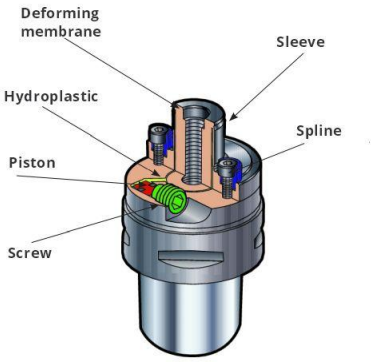
3) the emergence of new instrumental materials (cermets, cubic boron nitride, polycrystalline diamond, ceramics based on silicon nitride, etc.), resistant to wear, high temperatures and oxidation, and the ability to work at high cutting speeds;

4) the emergence of new types of cutting disc tool plates with universal and specialized multilayer Physical Vapor Deposition (PVD) and Chemical Vapor Deposition (CVD) coatings, as well as tools with high strength of their cases for bending and rupture, high resistance to the action of centrifugal forces, which parameters are optimized to the conditions of the technology of the HSM and HPM.

The increase of the efficiency of the technologies of the HSM and the HPM helps to make the right choice of all the factors involved in this process - CAD / CAM systems, CNC systems with the corresponding software, the design of the machine and its spindle, auxiliary tool (clamping cartridges and mandrels) for securing the cutting tool.

At present, machine-building enterprises are the most widespread high-speed milling with end and face mills, drilling, turning and boring.

In modern conditions, the technology of the HSM and HPM is intensively introduced into the production for the processing of complex configuration components from hard-working materials. In general, the required level of cutting speed v is extremely high and reaches: for billets of colored alloys v = 7000 ... 9000 m / min .; for billets of hardened steels v ≤ 2000 m / min .; for iron billet v ≤ 4000 m / min.



High cutting speeds require research into the effect on the design of the part under the HSM and the HPM of factors such as the size of the instrument beating, vibration, inertial loads, force and tool durability.

A significant reduction in the vibration of the tool can be achieved not only with the increase in the frequency of rotation of the end tool with the output to determine the frequency ranges, but also by adjusting its magnitude of departure from the spindle, depending on the diameter, number of grooves, type of fastening and other factors.

In most cases, the stability of the tool is related to the size of the beating the cutting edges relative to the axis of rotation. The beating, measured even by hundredths of a millimeter, has a significant effect on the stability of the instrument. If we talk about the finishing operations with the use of solid carbide mills, this effect is especially great (every 0.01 mm on medium-sized carbide mills reduces the durability of the tool twice). That is why the level of accuracy of tool holders is important not only in relation to the quality of processing, but also in relation to the stability of the tool and the predictability of the process.

With an increase in the spindle speed, the degree of imbalance becomes also a determining factor. Therefore, at high-speed processing, the huge advantage is the cartridges with individual balancing.

When milling the process of high-speed processing can be arranged at a small depth and high cutting speed at a small cross section of chips.

Work at such high revolutions raises the increased requirements for the use of equipment with the magnitude of imbalance. However, when rotating on separate elements of the axial tool holder, a centrifugal force acts and at high speed its value is already very large.

In order to provide high requirements for the installation of a tool at the HSM and HPM, HydroGrip and HydroMagic CoroGrip, clamping cartridges and mandrels from Sandvik Coromat (Sweden) are widely used to attach it to the spindles of modern high-speed milling machines.

Hydraulic and hydromechanical cartridges and mandrels are based on the principle of elastic properties of the material and allow to ensure high accuracy of the installation of the instrument and its minimum beating. The mechanism of operation of such cartridges is based on the properties of elastic deformation of a thin-walled steel membrane. The hydroplast itself is compressed under the action of the hydraulic pressure of the liquid, which is sprayed into the cartridge when the tool is fixed by turning the key. The hydraulic mandrel, expanding, provides centering of the cutter, which minimizes radial beating.

Figure 1 shows the construction of a hydro-plating mandrel (HydroGrip) for the installation of end mills on modern high-speed milling machines.

The advantages of such a clamping system are an increase of 2-3 times the life of the tool, small radial beating (0.003 mm), reliable transmission of the rotating torque at high processing speeds.

Thanks to the balancing, reliable fastening of the tool and the high effort transmitted such cartridges are recommended for use at a frequency up to 25 thousand min^{-1}. The sequence of setting the end cutter on the high speed HydroGrip is shown on Fig.2.

The high efforts and precision of fastening, combined with the individual balancing of the brackets, makes them most effective at high speed processing.

Thus, the advantages of HydroGrip hydro-level cartridges are an increase of 2-3 times the life of the tool, the precise installation of the instrument with radial beats up to 0.003 mm; transmission of high rotating moments (up to 980 Nm) with the optimized

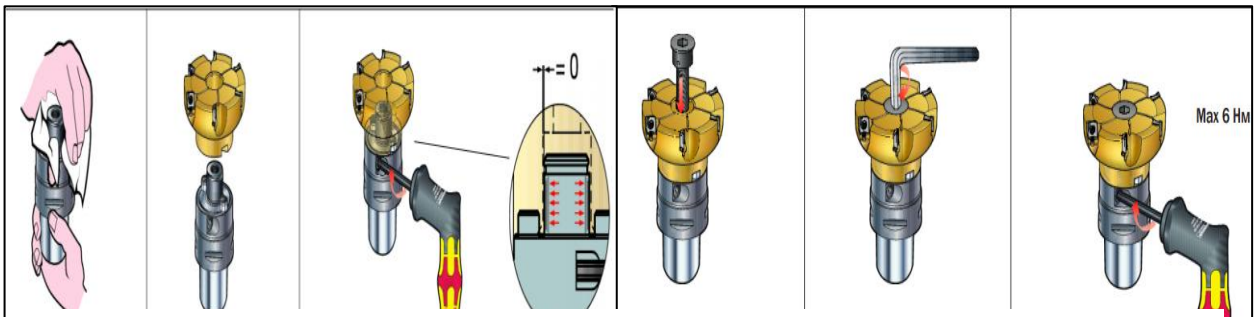


Fig.2 Sequence of installation of the face cutter on the HydroGrip mandrel:
1. Clean the surface of the milling cutter and the mandrel from the dirt and bolt; 2. Loosen the screw on the mandrel; 3. Plant the mill on the mandrel; 4. Insert screw fastening cutter; 5. Tighten the screw fastening cutter; 6. Tighten the screw on the hydraulic mandrel with a torque wrench (max torque 6 Nm).

design of a thin-walled membrane and a screw that transmits a high clamping force; effective application at high cutting speeds; absence of centrifugal forces due to the absence of fastening elements; Minimum beating, providing low roughness of the treated surface and stability of the size; quick tool change; optimum stability of the tool; extinguishing vibrations due to the hydroplastic medium.

Consequently, in order to increase the efficiency of modern HSM and HPM, special attention should be paid to the development and implementation of new auxiliary systems (clamping tool chucks and mandrels) that provide reliable fixing of the cutting tool on the machine tools and is an urgent task for the further development of modern HSM and HPM technologies.