INFLUENCE OF METHODS AND TECHNOLOGICAL CONDITIONS FOR PRODUCING CARBIDE INSERTS ON THEIR WEAR RESISTANCE WHEN PROCESSING PARTS FROM 40XH2MA

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Abstract. *At present, the problem of increasing the productivity of processing (increasing the cutting speed, depth of the cut layer, feed) while increasing the wear resistance of the tool is especially acute.*

This problem includes measures aimed at improving the machinability of titanium alloys and steels, improving the processing technology and design of cutting tools, and searching for and introducing new tool materials. The purpose of this work is to study wear resistance in industrial conditions and the effect of technological modes of obtaining T15K6 and T5K10 carbide inserts on their wear resistance and increase in machining productivity.

Keywords: *productivity, machinability, titanium, processing technology, T15K6, T5K10.*

Parts of a modern aircraft and aircraft engine operate under difficult conditions: they are exposed to heavy loads, variable temperatures and a chemically active harmful environment.

An aircraft designer, when creating a helicopter, aircraft or engine, chooses materials that provide reliable long-term operation of the structure with the least weight, are easy to process, and are inexpensive.

The final processing of complex-shaped parts of aircraft is achieved through the use of machining them on machines with numerical control. In modern machining production, expensive automated equipment, machine tools with numerical control, flexible production systems based on metalworking equipment with various configurations, controlled from a computer, are increasingly used. The operation of such equipment is characterized by a sharp increase in the cost of a machine-minute, tougher operating conditions of the cutting tool, an increase in the consumption of tool material and tool costs, which in some cases is up to 10-15% (and with many tool adjustments on multi-spindle machines, as well as when using expensive tool - up to 50%) of the cost of machining. Thus, increasing the cutting properties of the tool with a high probability of its trouble-free operation (high operational reliability), cutting intensification are the most important reserves for increasing the efficiency of machining production.

For the cutting part of a metalworking tool, tool steels, hard alloys, ceramics, as well as tool materials with wear-resistant coatings, etc. are used.

To fulfill its functional purpose, the following requirements are imposed on the tool material [1]:

– the hardness of the tool material must significantly exceed the hardness of the material being processed;

– tool material must have sufficient mechanical strength;

– high fracture resistance under alternating loading (high endurance limit);

– high heat resistance;

– tool material must have sufficient thermal conductivity;

– high wear resistance. The wear resistance of a tool material is determined by such properties as hardness, strength, heat resistance, crack resistance, etc.

Along with the requirements for the physical-mechanical and thermophysical properties of the tool material, a necessary condition for achieving sufficiently high cutting properties of the tool is the low physical and chemical activity of the tool material in relation to the material being processed.

The physical and chemical activity of a carbide tool in relation to the material being processed is a very important indicator, since parts made of various titanium alloys - BT-22, BT-8, OT-14, as well as complexly alloyed steels with very high strength, are increasingly being used in the aircraft industry, heat resistance and strength.

However, an increase in the long-term strength of materials at elevated temperatures, their short-term strength without a significant decrease in viscosity, an increase in fatigue resistance, corrosion resistance and other properties that ensure reliable operation of the structure under conditions of high power and thermal loads (including cyclic alternating loads and the action of aggressive media) cause difficulties. when processing titanium alloys, which, due to the specifics of their physical and mechanical properties, alloying systems and phase-structural transformations, can be processed at significantly lower cutting speeds than conventional structural materials.

Machining of high-strength steels and the choice of cutting tools, as well as cutting modes, remains the main task of increasing the productivity of machining aircraft parts.

At present, the problem of increasing the productivity of processing (increasing the cutting speed, depth of the cut layer, feed) while increasing the wear resistance of the tool is especially acute.

This problem includes measures aimed at improving the machinability of titanium alloys and steels, improving the processing technology and design of cutting tools, and searching for and introducing new tool materials.

As studies show, one of the main causes of wear and destruction of the cutting tool during machining of titanium alloys is adhesive wear, which is especially pronounced during machining under severe conditions with limited access of cutting fluids to the treated areas.

Thus, the physical-mechanical, thermophysical and crystal-chemical properties of the tool material strongly affect the performance of the cutting tool, and the optimal choice of a combination of these properties allows, within certain limits, to control tool wear processes and reduce the wear rate of tool pads.

In accordance with the requirements for the tool material, the choice of properties and a specific grade of material should be made taking into account the processing conditions, which are determined by the properties of the material being processed.

Carbide alloys, used as the cutting part of various tools compared to other materials, account for 50% of the entire world market; high-speed steels - 45%, ceramics - about 4%, polycrystalline diamond (PCD) and cubic boron nitride (CBN) - 1% [2,3].

The purpose of this work is to study wear resistance in industrial conditions and the effect of technological modes of obtaining T15K6 and T5K10 carbide inserts on their wear resistance and increase in machining productivity.

Experiments to determine the wear resistance of cutting tools equipped with T15K6 and T5K10 carbide inserts were carried out under industrial conditions. Cutting tools with mechanical fastening of hard-alloy inserts and cutters with brazed inserts were prepared.

Tests for wear resistance of hard-alloy plates were carried out during the processing of parts made of steel 40XH2MA.

The «bracket» part (figure, a), which has a complex structure, a large number of pockets with radius transitions of various sizes, is usually made of 40XH2MA steel.

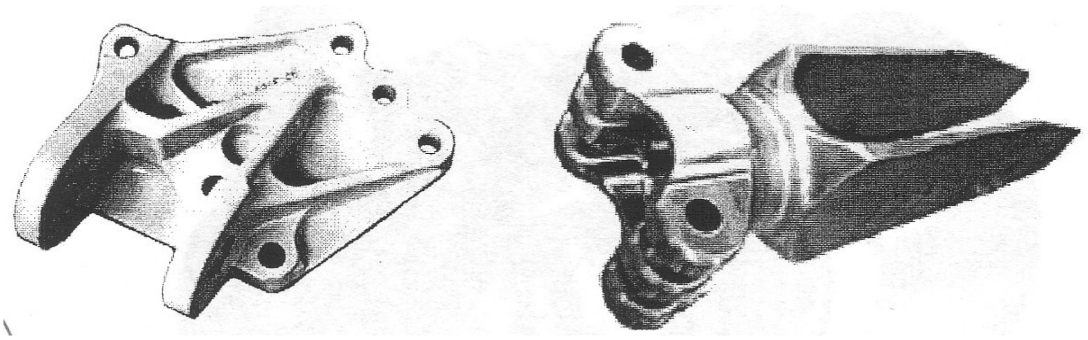
The complexity of machining the “tip” part (figure, b), which is also made of 40XH2MA steel, is due to the low rigidity of the cheeks, the possibility of their deformation under the action of cutting forces and internal stresses, and high shape accuracy.

Steel 40XH2MA belongs to the class of structural improved steels. It is used for the manufacture of critical welded and machined parts operating in atmospheric conditions at temperatures up to 500°C.

Chemical composition, %: 0.37 - 0.44 C; 0.17 - 1.37 Si; 0.5 - 0.8 Mn; 0.6 - 0.9 Cr; 1.25 - 1.65 Ni; 0.15 - 0.25 Mo; Fe is the basis.

Steel 40XH2MA after hardening heat treatment (quenching 870 - 890°C - cooling in oil - tempering at 510 - 670°C - cooling in oil) has the following mechanical properties: $\sigma_B \geq 110$ kgs/mm^2; $\sigma_{0,2} \geq 95$ kgs/mm^2; $\delta \geq 12\%$.

Machinability is satisfactory.



a) б)

Figure. Bearing parts made of 40XH2MA steel: a - bracket, b - tip of the helicopter main rotor blade

On a screw-cutting lathe mod. 1A670 processed the part - gear and gear shaft from 40XH2MA. Cutting conditions: spindle speed N= 8 rpm; cutting depth t= 10 mm (per side); feed S = 2.0 mm/min (table).

Table 1

Influence of the method of sintering and alloying a hard alloy with rhenium (Re) on the wear resistance of cutting tools with a T15K6 and T5K10 carbide insert when machining a part made of steel 40XH2MA

№	Tool name and carbide grade	Sintering method	Tool life (resistance) T, min
1	Through-hole cutter with T5K10 carbide insert	In the environment of hydrogen	Tool life 360 min - gearing per impact - with minimal wear.

2	Through-hole cutter with a T5K10 carbide insert with the addition of rhenium (Re)	In the environment of hydrogen	Tool life 150 min - impact machining - with minimal wear.
3	Through-hole cutter with a T15K6 carbide insert with the addition of rhenium (Re)	In the environment of hydrogen	Durability 300 min. - processing of teeth on blow - with the minimum wear.

Based on the research carried out, the following conclusions can be drawn:

- when processing a part made of steel 40XH2MA (second-hand gear shaft - processing of teeth for impact) - a cutter with a soldered hard-alloy plate from T5K10 (standard alloy sintered in a hydrogen environment) showed the best result;

- cutters with mechanical fastening are less preferred when machining parts with intermittent machining, i.e., for a hit.

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