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UTILIZATION OF HIGH-PREASSURE COOLING DURING FORMATION OF THE CHIP

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ABSTRACT
This article deals with the influence of high pressure cooling on chip formation during machining. It focuses on the analysis of standard and high-pressure cooling in turning parts made from Inconel 718. On the basis of comparison of these two cooling methods took place technical – economical evaluation with considering on creation of chips and wear of insert.
Keywords: high-pressure cooling, machining, Inconel 718

1. INTRODUCTION
The increasing requirements for quality, accuracy and durability in machinery products require application of new materials. One of these materials is INCONELL 718. This nickel alloy has high demands on processing thanks its mechanical properties. Machining strategy of this material usually places high demands on cutting tools, cutting conditions during machining parameters, stiffness and stability of the machine. As a result of hardening the surface layer of material after machining leads to decrease machinability. Influence of higher cutting speed leads to high concentration of heat at the cutting edge and thus rapid wear of the cutting tool. In order to avoid rapid wear and shortened service the life of cutting tools during machining is necessary to ensure effective heat dissipation from the cutting area. The inserts fulfil their function well, muss their temperature, but also the temperature of the workpiece to achieve a certain level. High temperatures make shorten tool life, while the low temperature results in inappropriate formation of chips. Therefore it is necessary to select suitable machining cooling system. Choose how cooling technology is adapted to the requirements for machining, used cutting tools and cutting conditions, the choice of machine, cooling unit and the technical, ecological and ultimately aesthetic aspects.

2. EFFECT OF COOLING IN MACHINING
When cutting metals up to 97% of the energy transformed into heat. The amount of this heat is at the cutting largely depends on the contact chips and tools, the size of cutting forces and friction processes between the work piece material and cutting edge tools. The cooling effect in this case is of considerable importance, because the largest amount of generated heat is drawn off just cutting fluid and chips. The cooling effect depends on many factors, mainly on the amount of process liquid supplied to the tool cutting performance per unit of time, and flow rate, the shape and direction of the process fluid due to the cut point, the viscosity, specific heat and thermal conductivity of process fluid. The way the process liquid supply to the cutting zone significantly influences the cutting process parameters, especially cutting edge tools and quality of the machined surface. At higher cutting speeds and high requirements for dimensional accuracy of the work piece is required rich heat dissipation. [1, 2]

3. HIGH COOLING

Proper adjustment of pressure and volume of the coolant results in the removal of heat from the cutting edge, thus preventing the creation of vapor barriers and local growth. An important part is the choice of a suitable cutting tool (eg Jetstream Tooling). Sufficient (2,36 $l.kW^{-1}$) highly compressed (up to 7 MPa) fluid entering into the cutting area can divert all the heat. It is important to set the pressure, but pressure alone is meaningless without volume. Correct setting pressure coolant enable to breaking chips (cold chip breaks much better and easier than hot chips). A large volume of liquid will ensure good lubrication and removes chips from the cutting edge. Reducing the temperature in the cutting edge with high-pressure cooling system, allowing up to 30% increase in cutting speed. High pressure coolant also reduces friction between chip and tool face, thereby improving finishing operations. [3, 4]

4. JETSTREAM COOLING

This cooling system has been specially designed by Seco Tools Ltd. to improve the machining of high-alloy in order to solve the problem of continuous supply of coolant to the cutting accurately. The exact directions to the coolant flow channels in the knife holder. This ensures accurate cooling inserts of cemented carbides, which are turning to new systems optimized for high-pressure cooling. During the machining is not necessary to modify the setting, which is especially important for unattended automated manufacturing systems. Coolant jets of high velocity jets located on the tool holder Jetstream Tooling. High-pressure coolant jet is directed straight to the point of cut, chip rises from the front instrument improves chip formation, extending tool life and allows increased cutting conditions during machining. [5]

5. EXPERIMENTAL PART

5.1. Effect of Cooling Mode on Chip Formation

Making chips is a very important factor that affects the tool wear, spindle and machine. The chip formation depends also the quality of surface finish. Based on this test was performed to monitor the production of chips using high pressure and low pressure cooling. The standard (low pressure) cooling generated long chips, which are harder to control, causing more damage and difficult to cut away from the place. The chips have a detrimental effect: may wrap around the spindle, the workpiece or tool, thereby causing damage. In standard cooling occurs in the chip cracks that are smaller and divided toward the depth. This causes a twisting of chips and not breaking its, look fig. 1. [3, 4]

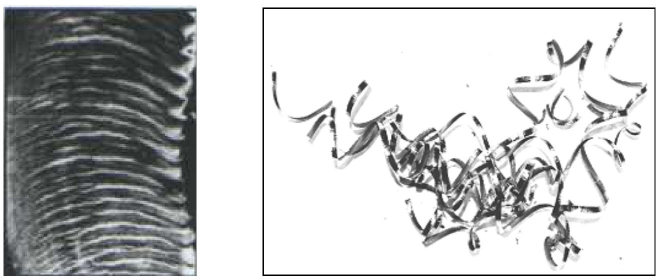

Figure 1. Chips resulting in turning the standard cooling.

On the contrary, high-pressure cooling system is so efficient that the chip rapidly cools, hardens and so much more fragile. To produce the short broken chips for high-pressure cooling is important to bring the coolant directly into the cutting edge. This causes rapid removal of chips from the cutting area by using the coolant flow. Coolant jets of high velocity jets located on the tool holder Jetstream Tooling, which helps you to split the fragile chip into even smaller pieces and removed easily to reduce the risk of chip. When high-pressure cooling of chips are cracks throughout the depth of long, smooth and even, look fig. 2. Along with lowering the temperature causes these cracks easily breaking chips. [3, 4]

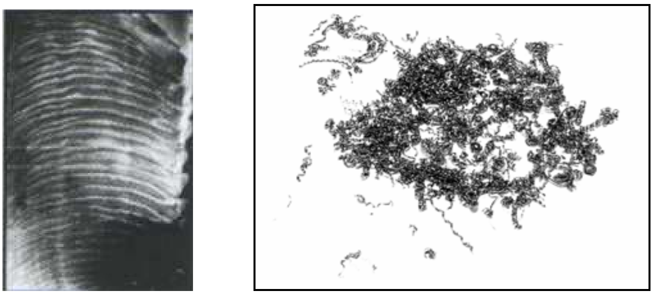

Figure 2. Chips came to in turning the high-pressure cooling.

5.2. Effect of cooling on tool wear

Cutting environment has a significant effect on tool wear, tool life and functional properties of the workpiece (machined surface roughness, machined surface hardening and residual stress in the surface layer). During machining has the largest influence on the wear of cutting tool plastic deformation, in places where there is friction between chip and tool face, or back tool and the workpiece. As a result, friction is generated at the contact surfaces of high temperature, which we greatly influences the wear on the front and back of the instrument. [2] When machining using standard cooling (cutting speed v_c 40 m.min^{-1}, feed v_f 0,35 mm and depth of cut a_p 4 mm) comes of a quite long chip, which twist around the tool and workpiece. This chip doesn´t allow access to the coolant to the cutting edge, and therefore faster wearing insert. Long chips are dangerous in terms of collision - a tool, chips, workpiece. Chip twist on the tool, workpiece and chip, for example, causes the inserts or other defects on the workpiece. This results in a decrease in the quality of the workpiece and the tools of destruction, so we try to prevent the formation of long chips.

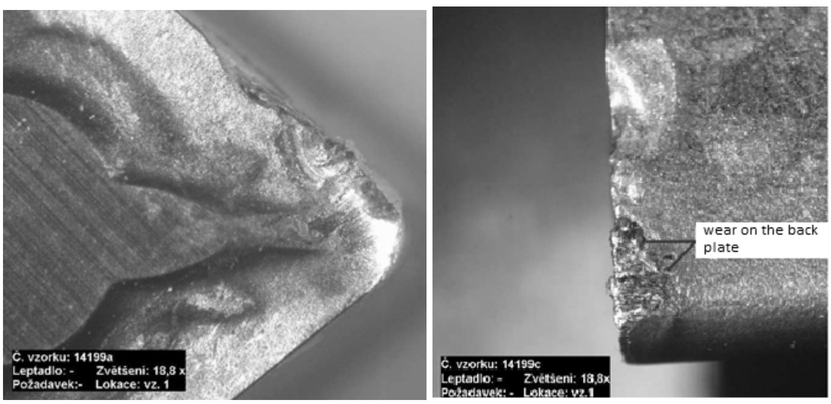

Figure 3. Temperature worn of insert when using the standard cooling.

Testing the effect of temperature on wear inserts was found that high-pressure cooling is able to extend the life of the insert. High pressure coolant during machining maintains a low temperature. Therefore, the formation of the harmful chemical reactions to produce long chips. Using the Jetstream Tooling has increased the cutting speed up to 90 m.min^{-1}, with the same feed rate and depth of layers of material. This way a specially adapted tool provides stable machining with coolant fed directly into the cutting edge. Tool life has been increased from 15 minutes to 26 minutes, tool wear and less heated. The introduction of high-pressure cooling, avoids wear and tear caused by the chip at cutting up to 90%. Reducing the temperature in the cutting edge with high-pressure cooling system, allowing up to 30% increase in cutting speed. In this type of cooling is much less head wear, and especially back tools wear, look fig. 4.

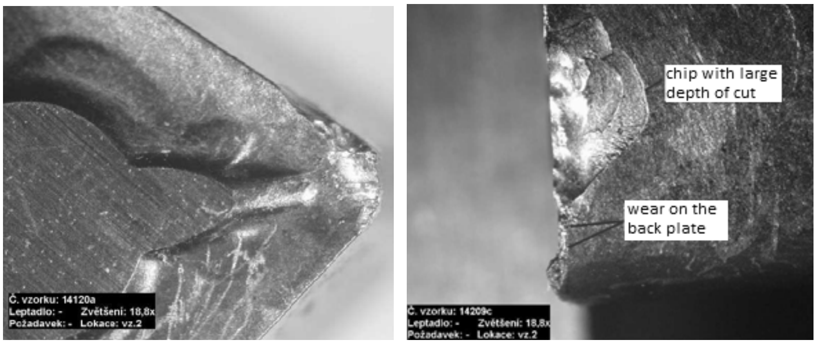

Figure 4. Temperature worn on insert when using high-pressure cooling.

6. TECHNICAL – ECONOMICAL EVALUATION

Based on the fact he was shown a beneficial effect on the course of high-pressure cooling machining nickel alloys. When using high pressure cooling increased quality due to the breaking of chips, chip removal from the working and cooling at the point of cut. High-pressure cooling unit increase durability and tool life, increase productivity and reduce production costs. On the other hand, high-pressure cooling increases the cost of energy consumption and costs associated with handling and operation of the machine.

Advantages of high pressure cooling:

- Reduced chip holding about 50%, and easy handling of chips.
- Improving the quality of up to 90% is sufficiently rapid and effective chip breaking, cooling and condensate from the cut (avoid collisions between the tool, workpiece and chip).
- Extension of the cutting tool life by up to 13%.
- Increased cutting speeds up to 5 to 10% thanks to superior heat dissipation.
- Better quality of machined surface and more effective chip breaking.
- On-site cooling section, there is no friction on the forehead and thus prevents of built.

Disadvantages of high cooling:

- Increased cost of high-pressure cooling and exchange of cutting slices.
- Warping of thin-walled parts due to high pressure.

7. CONCLUSION

The essence was to compare the technological aspects of the machining process using high pressure and low pressure cooling, determine the effect of cooling on the chip formation process and cutting tool wear. High-pressure coolant is a rapidly evolving technology that allows you to increase productivity, cutting speed, reduces the time of manufacturing operations, improves surface quality and significantly reduces the size of tool wear and thus extends their life. The selection of the cooling system allows the machine efficiently and wrong machinable materials.

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