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FEATURES OF THE HIGH-SPEED MACHINING OF THE HARD MATERIALS

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ОСОБЛИВОСТІ ВИСОКОШВИДКІСНОГО ОБРОБЛЕННЯ ТВЕРДИХ МАТЕРІАЛІВ

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High speed machining is one of the modern technologies, which in comparison with conventional cutting enables to increase efficiency, accuracy, and quality of workpiece. The first definition of high speed machining was proposed by Carl Saleman in 1931. They assumed that at a certain cutting speed which is 5-10 time higher than conventional machining. High speed machining is performed on material with hardness within the 45-68 HRC range using a variety of tipped or solid cutting inserts. These materials are difficult to machine and produce large amount of heat which leads to rapid wear of tool material. These kinds of materials can be machined by coated carbide tools such as TiAlN, TiN, TiCN, TiCON, Al_2O_3, cubic boron nitride (CBN), and polycrystalline cubic boron nitride (PCBN).

The definition of high-speed machining is based on the type of workpiece material being machined. Figure 1 shows generally accepted cutting speeds in high-speed machining of various materials.

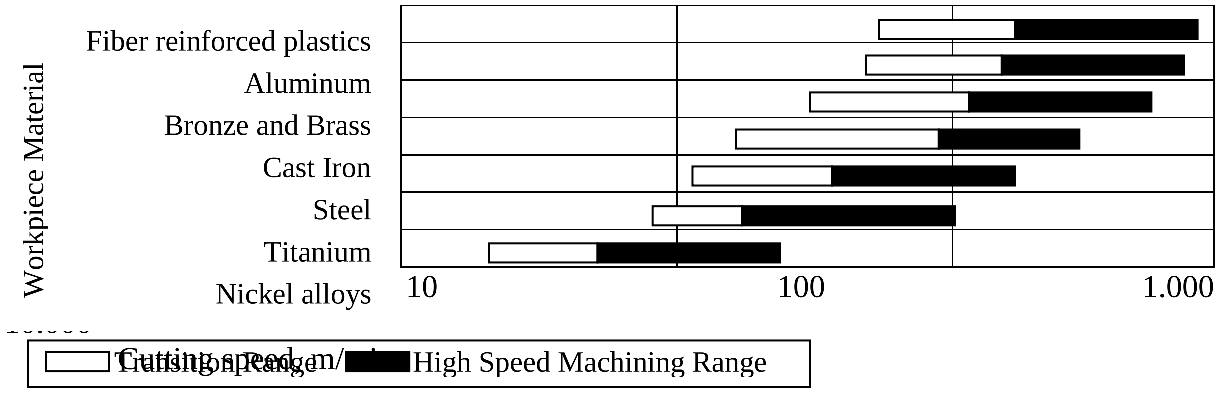

Figure 1 - High-speed cutting ranges in machining of various materials

The quality of the surface plays a very important role in the performance of machining because a good quality turned surface surely improve fatigue strength, corrosion resistance, creep life. Major advantage of high speed machining are high material removal rates, reduction in machining times, low cutting forces, dissipation of heat with chip removal resulting in decrease in workpiece distortion and increase part precision, developed good surface finish. The common disadvantages of high speed machining are excessive tool wear, need for specialand expensive tool holder and lastly but most importantly the need for advanced cutting tool material and coating.

High speed machining is being mainly used in three industry sectors due to their specific requirement. The first category is industry which deals with machining aluminium to produce automotive components, small computer parts or medical devices. This industry needs fast metal removal because the technological process involves many machining operations. The second category is aircraft industry which involves machining of long aluminum parts often with thin walls. The third industry sector is die mould industry which deals with finishing of hard materials. In high speed machining, the cutting speed affect on response variable such as cutting force, surface roughness, tool wear, heat generation, surface integrity, and chip formation. The methods commonly use to analysis of high speed machining experimental, analytical and numerical methods.

High-hardness materials includes various hardened alloy steels, tool steels, case-hardness steels, super alloys, nitride steels, hard-chrome coated steels and heat treated powder metallurgical parts. Finishing of hardened material using high speed machining using super hard cutting tools was early recognized by the automotive industry as a means of manufacturing of precisely finished transmission component.

Process parameters such as cutting speed, feed rate and depth of cut are affecting on production cost and product quality. Thus it is important to use optimization technique to determine optimal levels of these parameters so as to reduce the production cost and to achieve the desired product quality simultaneously. Therefore, if an increase in productivity is desired then an increase in these three cutting parameters is required. But, there are limits to these cutting parameters since they also have an effect on the tool life, tool wear, surface quality, surface integrity, cutting force, and heat generation. Many researchers have investigated effect of these parameters pertaining to the high speed machining.

On the basis of researches the technology abilities of high speed machining the major observation gleaned from the literature are the following:

High speed machining, the Taguchi method and ANOVA have proved to be efficient tools for controlling the effect on cutting force, tool wear and surface roughness.

The cutting forces are influenced not only cutting conditions but also cutting edge geometry.

The feed rate and depth of cut are the most significant factors of residual stresses. As well as feed rate, cutting speed, hardness of the material are dominant factors of surface roughness.

The cutting speed is most significant factor of cutting temperature, especially in high range of cutting conditions.

Flank wear and depth of cut notch (DOCN) wear are the dominant factor of tool wear. When cutting speed increases then tool life decreases. The longer tool life was observed in case of CBN/TiC cutting tools.

Saw toothed chips are always formed during the machining of hardened steel. Cutting tool wear and cutting forces are major influencing factors of chip morphology. Besides, one of the main factors for success in HSM applications is the total evacuation of chips from the cutting zone.

The complex phenomena involved in high speed machining can be studied through simulation and modeling using techniques such as FEM, ANN etc. and the results of the models can be validated with experimented results.