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Influence of Form Factor of the Cutting Edge on Tool Life during Finishing Milling

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Abstract

The article is focused on the influence of the cutting edge form factor, which is usually marked as K, on tool life and roughness of machined surface during finishing milling. The K factors were 0.55, 0.6, 1.6 and 2.5 and were made by drag finishing method. The tool edge rounding was 15μm. There was used a cutter head with just one indexable insert for finishing machining. The article can answer to question, if the K factor can help to increase the tool performance, because the influence of the asymmetrical form factor will be compared with symmetric form factor, it means K = 1. Tool edge was prepared by the technology of drag finishing.

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Keywords: form factor; tool life; milling; insert; stainless steel

1. Introduction

High productivity and especially high reliability of machining process is needed in industrial production. With regard to these demands, the micro-geometry of cutting edge is one of factors which influences tool wear (tool wear is related with tool life) and quality of machined surface. Blasting, brushing, drag finishing, magnetic honing, EDM as well laser machining are currently the most used technologies to create different type of cutting edge micro-geometry. Each of these methods has its own application area and it is also dependent upon its productivity, reproducibility and flexibility in terms of size and shape of required treatment. The design of cutting edge has influence on cutting forces, heat distribution, tool wear (tool life), roughness of machined surface, residual stresses, stability of machining process, etc [1, 2].

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The choice of "suitable" cutting edge micro-geometry still represents a problem and also the main trend of research and development. There are usually used abrasive or thermal edge treatments. These treatments are used both before and after tool deposition. Pre-deposition treatments are mainly used for reaching compact geometry; defects are removed from the edge. These defects were caused by grinding (burrs and micro-chipping). Further, the topography of cutting edge surface is positively influenced. The whole pre- and after- deposition treatments lead to higher mechanical stability and they are "know-how" of each tool producer [3]. In 2000 the study was done and its result is following, 10 ÷ 14% of production costs are invest into the cutting edge treatments. Cutting edge treatment is the process of tool edge transformation into chamfer or rounded shape. Size and shape is characterized by following parameters S_α, S_γ, r_n and K [4]. In the [5] is written that sharp edges with tool edge rounding $r_n < 5\mu m$, are produced by grinding. Grinding is also used for complex edge treatment, chamfering and for removing more material from a cutting edge. Middle size of edge rounding $5 < r_n < 20\mu m$ can be prepared by drag finishing, micro-blasting, magnetic honing, EDM or laser machining. Greater edge rounding $r_n > 20\mu m$ are prepared by brushing. A uniform micro-geometry of tool can be made by grinding technology. In contrast to above mentioned treatments technologies, parameters of grinding can influence the quality of the edge. Optimal cutting edge rounding depends on material of workpiece, tool material and cutting conditions [5].

To analyze the influence of cutting edge micro-geometry on cutting power is necessary to know the design of the micro-geometry. Denkena et al. and Bassett [3 and 6] introduced the method of edge treatment description which is based on definition of four basic parameters which can be seen in Fig. 1. These parameters are: S_α, S_γ, Δr and φ. The cutting edge can be both symmetrical and asymmetrical. Form factor:

$$K = \frac{S_\gamma}{S_\alpha} \quad (1)$$

K is called as form factor of symmetry. The K describes the direction of profile slope towards rake face (K>1) or flank face (K<1). This algorithm can be applied to data, which was obtained from stylus, optical and SEM measuring device [3 and 6]. For this purpose there was developed special measuring device which allows very fast, reliable and repeatable measuring the tool. Reliability and repeatability are the most important factors at this area. This contactless sensor head enables very precise and fast initial setup, so there is saved preparation time. The device was used for measuring all inserts and it is in detail described in [7].

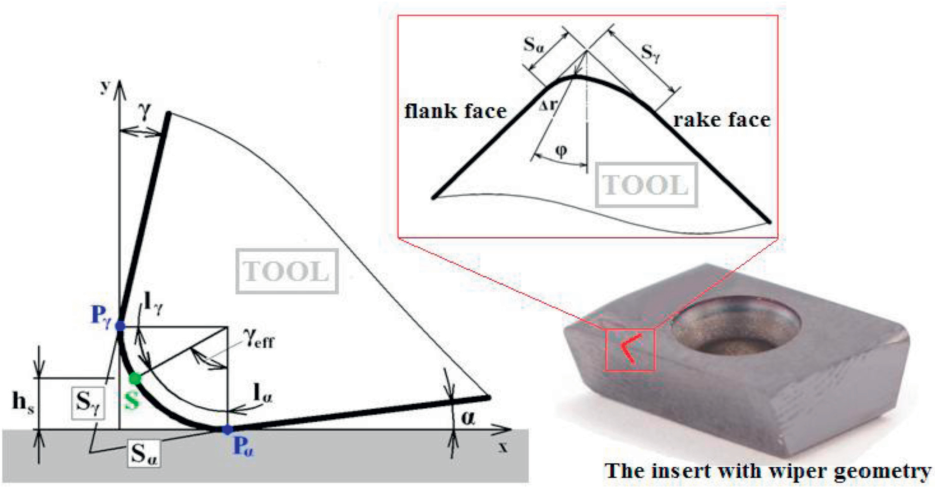

Fig. 1. Characterization of the cutting edge micro-geometry [4].

Denkena et al. wrote in the paper [8] that the material of workpiece can influence the results of cutting edge treatment. During milling of Inconel 718, this material has poor heat conductivity, there was found out that change of form factor K does not improve tool life in comparison with reference tool. During milling tool steel, where the main is abrasive wear due to very hard carbides which are contained in the base structure, both cutting edge treatment and form factor (which must be K > 1) has positive influence on tool life. The last tested material was Cr-Mo steel (42CrMoS4) which has better machinability and usually is machined as soft annealing. At this case the