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HARD TURNING OF HIGH-CARBON HIGH CHROMIUM TOOL STEEL USING CBN TOOLS UNDER DIFFERENT LUBRICATING/COOLING CONDITIONS

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ABSTRACT

The application of environment friendly cutting fluid in machining processes can strongly influence the wear on the cutting tools and the surface finish on work piece materials. This is only possible, when the cutting fluid provides better penetration into the cutting zone, thereby providing a better cooling and lubricating effect. Therefore, this study aims to show the effect of various cutting fluid cooling conditions and machining parameters on tool flank wear (VB) and surface roughness (Ra) of work piece while turning AISI D2 steel with coated CBN tools. Response surface methodology (RSM) and analysis of variance (ANOVA) were used to check the validity of quadratic regression model and to determine the significant parameters affecting the desired responses. The results showed that machining time was the most dominant parameter influencing both tool wear and surface roughness. Moreover, cutting fluid conditions also showed considerable contribution towards decreasing tool wear rate and increasing surface finish. In addition, the cutting tools were examined under scanning electron microscope (SEM) together with EDS. It was observed that abrasion along with BUE formation were the most dominant wear mechanism modes at low cutting speeds. However, at higher cutting speed and feed combinations, abrasions followed by diffusion and adhesion were the dominant form of wear mechanisms. Suppression of BUE was observed at higher cutting speeds of CBN tools. Finally, desirability function approach (DFA) was used to find out the optimal cutting parameters for minimum tool wear with maximum surface finish.

Keywords: Hard turning, RSM, CBN tools, Tool wear, Surface Roughness

1. INTRODUCTION

Machining of hardened materials having hardness greater than 45 HRC has become possible due to the recent advancement in cutting tool materials. Advanced cutting tools such as PCBN and ceramic tool materials have made it possible to machine difficult to cut materials under high cutting speed with or without the aid of cutting fluids. This process is replacing traditional and expensive finish machining process i.e. grinding process, because of the ability to machine complex work-piece geometries in single step with greater process flexibility, increased MRR and decreased set up times [1-2]. PCBN tools are widely used for machining tool steels, high speed steels, bearing steel and cast iron by the manufacturing industry and the researchers.

Within the frame-work of the comprehension of the phenomena occurring during the process of hard turning, various studies were carried out on different materials. However, the existing information or data in this field does not allow to generalise the obtained results and to predict the behavior of other materials. Therefore, the research on machining of these materials is continued. For example, Aouici et al. [3], Benlahmidi et al. [4], De Oliveira et al., [5], Ozel et al., [6], Sadik [7] performed hard turning of different steel grades and identified various parameters influencing tool wear, cutting forces and surface roughness using CBN tools. Also, Chou et al. [8] compared the performance of different CBN tools while finish hard turning of bearing steel. It was reported that the performance of low content CBN in terms of surface finish and tool wear was better than that of high content ones. Moreover, de Oliveira, [9] experimentally investigated the performance of CBN and ceramic tools while hard turning of AISI

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