MICROCUTTING PERFORMANCE MONITORING – INVESTIGATION ON TOOL FAILURE CRITERION

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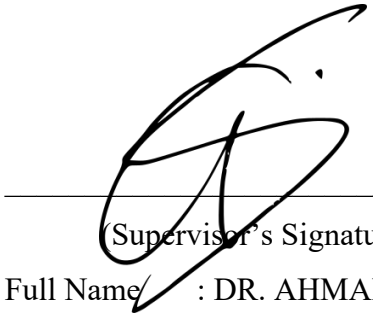

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ABSTRAK

Pada zaman ini, permintaan terhadap komponen bersaiz kecil daripada pelbagai industri seperti industri biomedikal, aeroangkasa, elektronik, automotif dan ketenteraan semakin meningkat seiring dengan perkembangan teknologi. Teknologi yang semakin berkembang menunjukkan corak perkembangan teknologi dari segi saiz komponen yang semakin kecil dan ringan tetapi masih mampu mempunyai fungsi yang sama atau lebih baik lagi. Salah satu proses yang dapat menghasilkan komponen bersaiz kecil adalah proses 'microcutting' di mana ia dapat menghasilkan komponen atau prototaip bersaiz mikro dgn kos yang efektif dan hasil yang berkualiti tinggi. Namun begitu, mesin khas bagi permesinan mikro agak mahal berbanding menggunakan mesin 'end milling' yang telah sedia ada untuk menjalankan proses 'microcutting'. Oleh sebab itu, kajian berkaitan tingkah laku 'tool wear' pada kelajuan permesinan yang rendah telah dijalankan pada bahan alloy aluminium 6065 dan keluli AISI 1045 di mana alat pemotongan karbid tungsten bersaiz 1.0mm dan mempunyai empat 'flute' digunakan. Ini adalah kerana salah satu dari faktor penting dalam proses 'microcutting' ialah alat pemotongan mikro itu sendiri. Kerosakan atau kecacatan pada alat pemotongan mempunya efek yang besar pada kos, kekasaran permukaan, fungsi dan kualiti akhir produk. Kajian ini dijalankan pada kondisi pemotongan yang berbeza dengan 'feed rate' daripada 0.001mm/tooth ke 0.005mm/tooth dan kelajuan pemotongan pada 3.142m/min hingga 9.425m/min melalui proses 'side milling' di mana perkembangan keadaan 'wear' bahagian tepi 'flank face' alat diukur. Kemudian, data kekasaran permukaan, dan saiz cip dikumpul menggunakan mikroskop pengukuran laser. Berdasarkan data yang telah terkumpul, didapati bahawa kerosakan pramatang alat yang berlaku sewaktu proses 'microcutting' tertumpu pada bahagian alat pemotongan dimasukkan pada bahan kerja. Selain itu, terdapat beberapa situasi di mana kekasaran permukaan menurun secara tiba-tiba apabila ia menghampiri zon retak. Ini disebabkan oleh efek geometri daripada alat yang telah tumpul. Ini boleh diaplikasikan pada reka bentuk alat pemotongan mikro untuk kegunaan pemotongan pada kelajuan rendah di masa akan datang. Pemilihan parameter pemotongan yang betul juga signifikan untuk mengurangkan kadar 'tool wear' dan memanjangkan hayat alat pemotong.

ABSTRACT

In recent years, there is an increasing demand for miniaturized components from various industries, such as biomedical, aerospace, electronics, automotive, and military industries, due to their technology advancement. As the technology advanced, the trend shows the components had become smaller and lighter but still carry out the same or more improved function. One of the processes that can create intricate small components is the microcutting process, where it can create micro sized components or prototype with cost effective and high-quality end product. However, the specific micro machining machine itself is expensive to own rather than using the conventional end milling machine that was already owned to carry out a microcutting process. In order to make this happen, this research studies the tool wear behaviour during low-speed microcutting of aluminium alloy 6065 and AISI 1045 steel material, where a tungsten carbide (wc) tool of 1.0mm and four flute is utilized. This is because we recognize that one of the essential factors in microcutting process is the micro cutting tool itself. The tool failure or wear effects the cost, average surface roughness, functionality, and the quality of the finished product greatly. The research is conducted under different cutting condition with varying feed rate of 0.001mm/tooth to 0.005mm/tooth and cutting speed of 3.142m/min to 9.425m/min using side milling process where the side flank face wear progression of the tool is measured. Then, the average surface roughness and chip size data are collected using a 3D laser measurement microscope. Based on the results, there is a similar tool wear trend of the microcutting process with the conventional methods. The tool shows more rapid wear rate and reduced tool life during micro cutting of AISI 1045 steel as it has higher material hardness compared to aluminium alloy 6065 although the machining process is still achievable. The premature tool failure of low-speed microcutting process is often focused on the entrance of the workpiece. Other than that, it is found that there are some instances where the average surface roughness had decreased abruptly when it is reaching the fracture zone, which is caused by the geometrical effect from the worn edge of the tool. This could be applied in future design of the micro tool suitable for low-speed machining. It is also concluded that appropriate selection of machining conditions has the potential to reduce tool wear rate and encourage longer tool life.

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