ADVANCED MACHINING TOWARDS IMPROVED MACHINABILITY OF DIFFICULT-TO-CUT MATERIALS

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Chapter 21

Modeling for Surface Roughness in End-Milling of Titanium Alloy Ti-6Al-4V Using Uncoated WC-Co Inserts

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1.0 INTRODUCTION

Titanium alloys are widely known as difficult to cut materials, especially at higher cutting speeds, due to their several inherent properties. Among all titanium alloys, Ti-6Al-4V is most widely used, so it has been chosen as the workpiece material in this study. Siekmann [1] suggested that machining of titanium and its alloys would always be a problem, no matter what techniques are employed to transform this metal into chips. When machining Ti-6Al-4V, conventional tools wear rapidly because the poor thermal conductivity of titanium alloys resulting in higher cutting temperature closer to the cutting edge. There also exists strong adhesion between the tool and workpiece material [2]. Since the performance of conventional tools is poor in machining Ti-6Al-4V, a number of newly evolved tool materials, such as cubic boron nitride (CBN) and polycrystalline diamond (PCD), are being considered to achieve high-speed milling [3].

In order to establish an adequate functional relationship between the responses (such as surface roughness, cutting force, tool life/wear) and the cutting parameters (cutting speed, feed, and depth of cut), a large number of tests are needed for each and every combination of cutting tool and work piece materials. This increases the total number of tests and as a result the experimentation cost also increases. Response Surface Methodology (RSM), as a group of mathematical and statistical techniques, is useful for modeling the relationship between the input parameters (cutting conditions) and the output variables. RSM saves cost and time by reducing the number of experiments required. A machinability model may be defined as a functional relationship between the input of independent cutting variables (speed, feed, depth of cut) and the output known as responses (tool life, surface roughness, cutting force, etc) of a machining process [4].

Response surface methodology (RSM) is a combination of experimental and regression analysis and statistical inference. RSM is a dynamic and foremost important tool of design of experiment (DOE), wherein the relationship between response(s) of a process with its input decision variables is mapped to achieve the objective of maximization or minimization of the response properties [5-6]. Many machining researchers have used response surface methodology to design their experiments and assess results. Kaye et al [7] used response surface methodology in predicting tool flank wear using spindle speed change. A unique