Chapter 9

Investigations on Machinability Characteristics of Hardened AISI H13 Steel With Multilayer Coated Carbide Tool Using Statistical Techniques

R. Suresh
M. S. Ramaiah University of Applied Sciences, India

Ajith G. Joshi
Canara Engineering College, India

ABSTRACT

Hard turning with multilayer coated carbide tool has several benefits over grinding process such as, reduction of processing cost and increased productivity. The objective was to establish a correlation between cutting parameters with cutting force, tool wear and surface roughness on workpiece. In the present study, machinability of AISI H13 steel with TiC/TiCN/Al2O3 coated carbide tool using statistical techniques. An attempt has been made to analyze the effects of process parameters on machinability aspects using design of experiments. Response surface plots are generated for the study of interaction effects of cutting conditions on machinability factors. The obtained results revealed that, the optimal combination of low feed rate and low depth of cut with high cutting speed is beneficial for reducing machining force. The cutting tool wears increases almost linearly with increase in cutting speed and feed rate. The combination of low feed rate and high cutting speed is necessary for minimizing the surface roughness.

1. INTRODUCTION

1.1. Hard Turning

Hard machining is a term referred to machining of hardened alloys possessing hardness generally greater than 45 HRc. Generally the alloys which are having hardness in the range of 45-65 HRc are considered in many engineering applications such as automotive, power plants, etc. They are gaining prime signifi-
Investigations on Machinability Characteristics of Hardened AISI H13 Steel

cance due to their properties such as excellent tribological characteristics, better fatigue strength and so on (Suresh et al., 2013). Heat treated ferrous alloys, usually owes to the hardness in this range when they are in order to obtain desired mechanical properties combined with surface integrity, dimensional accuracy and shape. Stellites, Inconel, high chrome coating, carburized and nitride iron are other candidates of hard materials (Mohandas et al., 2012).

The challenges are still being machining of such hardened alloys. Hard turning is being considered as one of the significant machining technology for machining hardened alloys. The present developments in manufacturing industries are towards replacing grinding of hardened steels with hard turning due to capabilities such as reduced costly equipments, long setup time and manufacturing cycles. In specific, finish hard turning is the evolving technique towards replacement of grinding and electrical discharge machining for manufacturing components which requires greater tolerances and surface finish such as bearings, transmission shafts, axles, etc. The major advantages of hard turning over grinding are complex contour shape, the comparable surface finish and dry machining can be achieved. While, hard turning is a technology driven process that requires performance characteristics of machine tool such as rigidity, good work clamping devices, tooling systems and so on. Hence hard turning cannot be accomplished on all types of machine tools that limit the application of hard turning. However, technology is being developed and imparted in present manufacturing CNC lathes with greater rigidity required for hard turning.

The fundamental issues related to hard turning such as rapid tool wear and surface integrity still exists, which needs attention to make it feasible process. Since, only very hard and advanced tools are used in the process that adds to the cost of tools subsequently large down time due to frequent tool change. Hard and brittle white layer occurrence is another major issue that causes component to get premature failure or affects the service performance. The white layer formation occurs because of tensile residual stress over the machined surface and subsurface. Thus, white layer formation favors premature failure of components due to reduced fatigue strength at points such as subsurface voids, cracks or inclusions. While the compressive residual stress arrests cracks formation and growth at such subsurface defects. Normally hard turning is employed at high cutting speeds. In such condition, both material as well as tool experiences extreme conditions of high strain rate of order $10^5$ and high temperature around $1200^\circ$ C (Ashley, 1995, Aouici & Yallese, 2013). Hence cutting tool and optimized process parameter selection are two major problems which are focused in the current chapter.

1.2. Literature Survey

Aouici et al. (2013) studied the influence of cutting speed, feed, workpiece hardness and depth of cut on cutting force components and surface roughness during machining of hardened AISI H11 steel using CBN tools. The relationship between the variables and the technological parameters was determined through the response surface methodology (RSM), using a quadratic regression model. Caydas et al. (2010) carried out machinability evaluation in dry turning of hardened AISI 4340 steel with different cutting tools using statistical techniques. A detailed statistical investigation was made by using analysis of variance, Tukey—Kramer comparison, and correlation tests. The best combination of cutting parameters for determining optimal conditions and the influence of each factor on the response were revealed.