Available online at www.sciencedirect.com

ScienceDirect

Procedia Manufacturing 20 (2018) 377–385

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

2nd International Conference on Materials Manufacturing and Design Engineering

# Comparative machinability performance of heat treated 4340 Steel under dry and minimum quantity lubrication surroundings

Rabin Kumar Das*, Ashok Kumar Sahoo, Purna Chandra Mishra
Ramanuj Kumar, Amlana Panda

*School of Mechanical Engineering, Kalinga Institute of Industrial Technology, Deemed to be University, Bhubaneswar-751024, Odisha, India*

**Abstract**

Finish hard turning using coated carbide tools of various layers of coating under different environments of machining process has been raised as a new technique in the field of machining by report to the conventional rectification and to be extensively treasure-trove its utilization manufacturing industry. To achieve a better life of the insert and a better finishing the surface temperature at the cutting area must be controlled, which could be achieved by machining under MQL state. Therefore an experimental survey was conducted on various aspects of the machinability such as wear of the insert and average quality of the machined surface utilizing multilayer coated carbide insert in the turning of the hardened AISI 4340 under the state dry and MQL. The detailed investigation has revealed that multilayered coated carbide insert has generated a good surface quality and executed in the scope of the recommended level of 1.6 microns under the two environments. It was confirmed that the abrasion is the main mechanism of wear under the both conditions of machining. Inserts made of carbide multilayer coated gave satisfactory performance in the MQL state in relation to the dry state. The surface finish was also higher in the MQL condition rather than dry. Cutting speed has been the most imperative process parameter regarding the wear on the flank surface and the speed predominates on the roughness of the turned surface.


Peer-review under responsibility of the scientific committee of the 2nd International Conference on Materials Manufacturing and Design Engineering.

*Keywords:* Flank wear, MQL, Surface finish, Chip morphology.

* *E-mail address:* rabin.kumar88@gmail.com

2351-9789 
Peer-review under responsibility of the scientific committee of the 2nd International Conference on Materials Manufacturing and Design Engineering.
10.1016/j.promfg.2018.02.055

## 1. Introduction

Machining of heat treated hardened steel component with hardness 50±1 HRC, has gain immense popularity as a novel alternative to typical grinding operation is a cost-benefit and a malleable machining process for metal component containing ferrous element. Turning of hard to cut materials has been made easy with evolution of superior cutting tool material and distinctive coating technology which produce cutting inserts having superior hardness value, resistant to wear and chemical balance of the coatings which offers confirm perks in case of life of the cutting insert and machining achievement. Machining in dry environment is the suitable condition to perform hard turning operation, as maximum amount of heat is generated which helps to soften the upper surface of hardened steel, hence making machining easy. But the chunk of heat produced at the insert and work material interaction zone needs to be controlled, so as to minimize wear on tools flank surface and protecting the work piece surface from experiencing unwanted residual stress which could lead to failure of the work material. So as to face this major challenge in hard machining divergent lubricating techniques were introduced which replaced traditional flooded lubrication technique, which in hand helped in cost cutting of overall machining cost by eliminating excessive use of lubricant and also help in creating an environment friendly machining condition. Minimum quantity lubrication (MQL) is one among the divergent lubricating technique which researcher across the scientific fraternity are putting their efforts in investigating its impact in area of hard machining. Attanasio et al. studied that by reducing the use of cutting fluid in machining many advantages like worker's safety, environmental and cost effective benefits were obtained. It was found that when minimum quality lubrication was applied to tool surface, life of the tool enhanced [1]. Rao et al. stated that use of solid lubricants in turning have better results over traditional fluids used in machining. It improves overall process achievement by reducing machining forces and wears at tool surface and provides better surface finish. [2]. Elmunafi et-al observed that the performance was better during MQL using castor oil as machining fluid over dry machining during machining of heat treated stainless steel. By using MQL the life of the tool was longer as compared to dry machining. Roughness of the surface and forces involved in cutting also boosted minimally as a result of decrease in temperature generated in the machining zone. [3]. Weinert et al. concluded by using MQL processes are highly productive and higher performance was archived with slight reduction in production time. Dry machining is mainly suitable for large scale industries where production is very large. Betterment in research technology and increasing number of industrial application in field of dry machining and MQL would expand its use in small and medium sized manufacturers [4]. Dhar et al. experimented the mechanical output of dry lubrication with MQL for turning of 1040 grade steel by measurement of machining forces, tools wears, chip reduction co efficient, machining temperature, surface and deviation of dimension. It was found that by using near dry lubrication resulted in lower machining force, decrease in tool wears, surface roughness and dimensional deviation [5]. Dhar et al. experimented the outcome of MQL on temperature of cutting zone, quality of turned product and formation of chip in turning 1040 grade steel at divergent speeds and axial feed sequence using uncoated carbide tool. By using MQL machining better cutting performance, decrease in cutting temperature and improved chip tool interaction, better dimensional accuracy was found compared with conventional machining [6]. Netake et al. predict the forces involved in cutting operation and surface quality while hard turning of heat treated alloy grade steel by MQL employing PVD coated nano crystalline TiSiN-TiAIN coated carbide tool. The models were reliable and could be used exclusively to predict the machining forces and surface roughness as correlation coefficient found was 0.9 [7]. Liang et al. compared the mechanical performance of MQL for turning hardened bearing grade steel materials using completely dry lubrication method. It was observed that the surface roughness, temperature during cutting operation decreased, tool flank wear was delayed but it also had a minimal effect on the machining forces [8]. Khan et al. described the effect of MQL performance related to finish hard turning of low alloy correlated with dry cutting and wet cutting while using vegetable oil based cutting lubricant. Up to 10% reduction in average chip tool interface temperature was found using MQL system. Chips surface appeared much brighter and smoother in case of MQL and build up edge formation was absent. Using MQL system tool wear was greatly reduced and surface finish had improved [9]. Vyas et al. discussed the cause for the formation of saw tooth chip in metal cutting. Saw tooth chip formed when very hard and brittle materials were machined at high speed and feeds. This formed due to thermal origin and cyclic cracking in the original surface. Gross cracks and micro cracks were involved in saw tooth clip formation [10]. Jain et al. discussed the various advantages of MQL over flooded cooling. Longer tool life, improved surface quality, better chip formation, decrease in cutting temperature and reduction in machining force was obtained using MQL [11]. Kumar et al. experimentally analyzed the surface quality of finished product under MQL and wet conditions. Surface quality improves from 7-