

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

Edited by:

A.K.M. Nurul Amin (Chief Editor)

Dr. Erry Yulian Triblas Adesta

Dr. Mohammad Yeakub Ali



IIUM PRESS

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

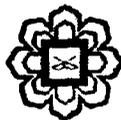
ADVANCED MACHINING
TOWARDS IMPROVED MACHINABILITY OF
DIFFICULT-TO-CUT MATERIALS

Edited by:

A.K.M. Nurul Amin (Chief Editor)

Dr. Erry Yulian Triblas Adesta

Dr. Mohammad Yeakub Ali



IIUM Press

Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011
©IIUM Press, IIUM

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without any prior written permission of the publisher.

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

Advanced Machining Towards Improved Machinability of Difficult-To-Cut Materials: A.K.M.
Nurul Amin, Erry Yulian Triblas Adesta & Mohammad Yeakub Ali

ISBN: 978-967-418-175-8

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM
(Malaysian Scholarly Publishing Council)

Printed by :
IIUM PRINTING SDN.BHD.
No. 1, Jalan Industri Batu Caves 1/3
Taman Perindustrian Batu Caves
Batu Caves Centre Point
68100 Batu Caves
Selangor Darul Ehsan
Tel: +603-6188 1542 / 44 / 45 Fax: +603-6188 1543
EMAIL: iiumprinting@yahoo.com

SECTION A: HEAT ASSISTED MACHINING	1
1. CHAPTER 1: INFLUENCE OF WORKPIECE PREHEATING ON CHATTER AND MACHINABILITY OF TITANIUM LOY - TI6AL4V	1
2. CHAPTER 2: MACHINABILITY IMPROVEMENT IN END OF MILLING TITANIUM ALLOY TI-6AL-4V THROUGH PREHEATING	9
3. CHAPTER 3: SOME ASPECTS OF IMPROVED MACHINABILITY IN PREHEATED MACHINING OF TITANIUM ALLOY TI-6AL-4V	19
4. CHAPTER 4: MACHINABILITY ASPECTS IN HEAT ASSISTED MACHINING OF HARDENED STEEL AISI H13 USING COATED CARBIDE TOOL	27
5. CHAPTER 5: TOOL WEAR AND SURFACE ROUGHNESS ASPECTS IN HEAT ASSISTED END MILLING OF AISI D2 HARDENED STEEL	35
6. CHAPTER 6: MODELING IN PREHEATED MACHINING OF AISI D2 HARDENED STEEL	43
7. CHAPTER 7: RELATIVE PERFORMANCES OF PREHEATING, CRYOGENIC COOLING AND HYBRID TURNING OF STAINLESS STEEL AISI 304	49
SECTION B: CHATTER AND SELECTED METHODS OF CHATTER SUPPRESSION	57
8. CHAPTER 8: ROLE OF THE FREQUENCY OF SECONDARY SERRATED TEETH IN CHATTER FORMATION DURING TURNING OF CARBON STEEL AISI 1040 AND STAINLESS STEEL	57
9. CHAPTER 9: INFLUENCE OF THE ELASTIC SYSTEM AND CUTTING PARAMETERS ON CHATTER DURING MACHINING OF MILD STEEL	65
10. CHAPTER 10: INFLUENCE OF CHATTER ON TOOL LIFE DURING END MILLING OF ALUMINIUM AND ALUMINIUM ALLOY ON VMC	75

11	CHAPTER 11: A NEW METHOD FOR CHATTER SUPPRESSION AND IMPROVEMENT OF SURFACE ROUGHNESS IN END MILLING OF MILD STEEL	83
12	CHAPTER 12: APPLICATION OF PERMANENT ELECTROMAGNET FOR CHATTER CONTROL IN END MILLING OF MEDIUM CARBON STEEL	91
13	CHAPTER 13: APPLICATION OF PERMANENT ELECTROMAGNET FOR CHATTER CONTROL IN END MILLING OF TITANIUM ALLOY - Ti6Al4V	99
14	CHAPTER 14: CHATTER SUPPRESSION IN END MILLING OF TITANIUM ALLOY Ti6Al4V APPLYING PERMANENT MAGNET CLAMPED ADJACENT TO THE WORKPIECE	107
	SECTION C: MODELING AND OPTIMIZATION IN MACHINING	117
15	CHAPTER 15: A COUPLED ARTIFICIAL NEURAL NETWORK AND RSM MODEL FOR THE PREDICTION OF CHIP SERRATION FREQUENCY IN END MILLING OF INCONEL 718	117
16	CHAPTER 16: APPLICATION OF RESPONSE SURFACE METHODOLOGY COUPLED WITH GENETIC ALGORITHM FOR SURFACE ROUGHNESS OF INCONEL 718	123
17	CHAPTER 17: DEVELOPMENT OF A MATHEMATICAL MODEL FOR THE PREDICTION OF SURFACE ROUGHNESS IN END MILLING OF STAINLESS STEEL SS 304	133
18	CHAPTER 18: DEVELOPMENT OF AN ARTIFICIAL NEURAL NETWORK ALGORITHM FOR PREDICTING THE CUTTING FORCE IN END MILLING OF INCONEL 718 ALLOY	143
19	CHAPTER 19: DEVELOPMENT OF AN ARTIFICIAL NEURAL NETWORK ALGORITHM FOR PREDICTING THE SURFACE	149
20	CHAPTER 20: DEVELOPMENT OF TOOL LIFE PREDICTION MODEL OF TiAlN COATED TOOLS DURING PART C: HIGH SPEED HARD MILLING OF AISI H13 STEEL	155
21	CHAPTER 21: MODELING FOR SURFACE ROUGHNESS IN END-MILLING OF TITANIUM ALLOY Ti-6Al-4V USING UNCOATED WC INSERTS	161

22	CHAPTER 22: MODELING OF SURFACE ROUGHNESS DURING END MILLING OF AISI H13 HARDENED TOOL STEEL	167
23	CHAPTER 23: MODELING OF TOOL LIFE USING RESPONSE SURFACE METHODOLOGY IN HARD MILLING OF AISI D2 TOOL STEEL	175
24	CHAPTER 24: OPTIMIZATION OF SURFACE ROUGHNESS IN HIGH SPEED END MILLING OF TITANIUM ALLOY Ti-6Al-4V UNDER DRY CONDITION	181
25	CHAPTER 25: COMPARISON OF SURFACE ROUGHNESS IN END-MILLING OF TITANIUM ALLOY TI-6AL-4V USING UNCOATED WC-CO AND PCD INSERTS THROUGH GENERATION OF MODELS	189
26	CHAPTER 26: ASSESSMENT OF PERFORMANCE OF UNCOATED AND COATED CARBIDE INSERTS IN END MILLING OF TI-6AL-4V THROUGH MODELLING	195
	SECTION D: CRYOGENIC AND HIGH SPEED MACHINING OF METALS AND NON METALS	203
27	CHAPTER 27: THE EFFECT OF CRYOGENIC COOLING ON MACHINABILITY OF STAINLESS STEEL DURING TURNING	203
28	CHAPTER 28: COMPARISON OF MACHINABILITY OF CERAMIC INSERT IN ROOM TEMPERATURE AND CRYOGENIC COOLING CONDITIONS DURING END MILLING INCONEL 718	209
29	CHAPTER 29: HIGH SPEED END MILLING OF SINGLE CRYSTAL SILICON SING DIAMOND COATED TOOL	217
30	CHAPTER 30: IMPLEMENTATION OF HIGH SPEED OF SILICON USING DIAMOND COATED TOOLS WITH AIR BLOWING	225
31	CHAPTER 31: ELIMINATION OF BURR FORMATION DURING END MILLING OF POLYMETHYL METHACRYLATE (PMMA) THROUGH HIGH SPEED MACHINING	233
32	CHAPTER 32: WEAR MECHANISMS IN END MILLING OF INCONEL 718	239

33	CHAPTER 33: PERFORMANCE OF UNCOATED WC-CO INSERTS IN END MILLING OF ALUMINUM SILICON CARBIDE (ALSiC)	247
34	CHAPTER 34: APPLICATION OF PCD INSERTS IN END MILLING OF ALUMINUM SILICON CARBIDE (ALSIC)	253
35	CHAPTER 35: EFFECTS OF SCRIBING WHEEL DIMENSIONS ON LCD GLASS CUTTING	259

Comparison of Machinability of Ceramic Insert in Room Temperature and Cryogenic Cooling Conditions during End Milling Inconel 718

A.K.M. Nurul Amin^{1*}, Suhaily Mokhtar¹, Anayet U Patwari¹, A. Hazim¹, Z. Adlan¹

¹Department of Manufacturing and Materials Engineering
Faculty of Engineering, International Islamic University Malaysia,
Jalan Gombak, 53100 Kuala Lumpur, Malaysia

*Corresponding author's e-mail: akamin@iium.edu.my

1.0 INTRODUCTION

Nickel based super alloy or Inconel 718 is known as heat resistant alloys which they are primarily used in gas turbine, steam turbine component and aircraft engine component construction [1]. Inconel 718 attained several unique combinations of properties like strength at elevated temperature, resistance to chemical degradation and wear resistance [2]. However, their ability to maintain these properties at elevated temperatures severely deters the machinability of the alloy, thus it is generally regard to as difficult to machine alloy [3]. The properties of nickel based alloys that contributes to the difficulties in their machining are summarized as follows: (i) major part of its strength is maintained during machining due to high temperature properties; (ii) work hardening occurs rapidly during machining which an ultimate input to notch wear at the tool nose; (iii) cutting tools suffer from high abrasive wear due to the presence of hard abrasive carbides particles in the material; (iv) chemical reaction occurs at high cutting temperatures when machining with normal cutting tool materials, which leads to a high diffusion wear rate; (v) adhesion of nickel alloys onto the cutting tool frequently occur during machining which causing severe notching on the tool rake face due to consequent pull-out of the tool materials; (vi) production of a tough and continuous chip which is difficult to control during machining thus contributing to the degradation of the cutting tool by seizure and cratering; and (vii) poor thermal conductivity of nickel based alloys frequently generates high temperature at the tool tip as well as high thermal gradients in the cutting tool [4]. Due to deprived machinability factors mentioned above, tool life attained when machining nickel based alloys are severely insufficient [5]. Most of main key parameters such as choice of tool materials, tool geometry, machining method, cutting variables and conditions become the causes to achieve sufficient tool life during machining [6]. Several studies on the machining of nickel based alloys had been performed with the use of different tool materials that will contribute to improve machinability and ensure of longer tool life and better surfaced integrity of machined components.

Several studies on the machining of nickel based alloys had been performed with the use of different tool materials that will contribute to improve machinability and ensure of longer tool