Research Article

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Turning operation of AISI 4340 steel in flooded, near-dry and dry conditions: a comparative study on tool-work interface temperature

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Abstract: The objective of this study is to analyse the effect of tool-work interface temperature observed during the turning of AISI 4340 cylindrical steel components in three machining conditions, namely flooded, near-dry and dry conditions with three separate CNMG-PEF 80^0 diamond finish Titanium Nitride (TiN) coated carbide cutting tool. The machining parameters considered in this study are cutting velocity, feed rate and depth of cut. The experiments were planned based on full factorial design (3^3) and executed in an All Geared Conventional Lathe. The tool-work interface temperature was observed using a K-type tool-work thermocouple, while the machining of steel, and subsequently, a mathematical model was developed for the tool-work interface temperature values through regression analysis. The significance of the selected machining parameters and their levels on tool-work interface temperature was found using analysis of variance (ANOVA) and F-test. The results revealed that machining under near-dry condition exhibited lesser temperature at the tool-work interface, which is the sign of producing better quality products in equivalence with the machining under flooded condition.

Keywords: AISI 4340, tool-work interface temperature, flooded, near-dry, dry, ANOVA

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Nomenclature

AISI	American Iron and Steel Institute
C	Carbon
CNMG	ISO designation for tool
Cr	Chromium
Cu	Copper
d	Depth of cut in mm
f	Feed rate in mm/rev
Fe	Ferrous
Mn	Manganese
Mo	Molybdenum
NDM	Near-dry machining
Ni	Nickel
PCLNR	ISO designation for tool holder
PEF	ISO designation for insert chip breaker geometry
r	Correlation coefficient
Si	Silicon
T	Tool-work interface temperature in °C
v	Cutting velocity in m/min

1 Introduction

In the present day manufacturing environment, machining operations are inevitable in producing finished products. In any machining operation involving metal cutting, the usage of lubricants plays a vital role in maintaining favourable manufacturing conditions [1]. The favourable manufacturing conditions are a combination of certain process parameters and conditions, due to which best quality machine components are produced [2, 3]. Above 95% of gross energy sustained to the machine tool is changed over into heat, because of the relative movement between the cutting tool and workpiece [4, 5]. This form of heat energy is considered to be a waste and such a form of generated heat causes poor product surface quality and wear and tear of the tools [6].