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EFFECT OF MQL ON EN24 STEEL UNDER NOVEL TEXTURE TOOL IN TURNING PROCESS: COMPARATIVE STUDY

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Abstract
Machining of difficult to cut materials with conventional cutting tools were increases the damage of cutting edge, poor surface quality and pollute the environment. To overcome these problems, textured tool was developed in current study and experiments performed on EN24 alloy steel under Minimum quantity lubrication (MQL) medium. In the current study, comparison of untexture (UN) and circular pit hole texture (CT) under MQL environment. However, output machined parameter significantly reduced cutting force (F_f) to a maximum of 8% over NT under MQL. The established texture tool with MQL significantly enhances the productivity and eco-friendly in nature.

Key words: EN24, MQL, cutting force, CT, UN.

1. Introduction
Enormous usage and demand of EN24 alloy steel in field of automobile, aircraft, gears, bolts and studs manufacturing industries are much attention to the researches, due to its good mechanical properties of tensile strength and elongation. Still a challenge for the industries in machining of EN24 alloy steel under conventional tools with dry and flood cooling. Here, more smoke and un-disturbed noises were generates under dry cutting and wastage of coolant is more in flood cooling method. Consequently, produces the environmental hazards and cost of product respectively. Textured tools with novel cooling MQL method significantly overcomes above difficulties. SharmaV and PandeyPM [1] parallel, perpendicular, cross-textured, elliptical and dimples were fabricated on tungsten carbide tool in cutting of Ti–6Al–4v alloy .In machining process Lagrangian formulation was used for simulation .Author conclude that, textured geometry plays vital role for significant results of cutting force and tool wear respectively. Recently, under MQL medium, researchers turned to various difficult-to-cut materials while using traditional cutting tools. Javid et al.[2] under MQL and nano-MQL, turning experiments were carried on HSLA steel ,respectively. Authors shows that, nano-MQL substantially reduce the friction at machined zone over MQL, accordingly. Moreover, found the optimum cutting parameters to enhance the machined performance by RSM method .Muhammad et al.[3] on Inconel 718, executed milling experiments and look over on chip morphology and surface roughness with coated tools and cutting setting parameters. In this connection, cutting velocity plays outperformed roll on machined characteristics respectively. Hen et al.[4]At various cooling methods , cutting experiments were performed on AISI 1040 under textured and untextured tools. Authors revealed that, low contact length of tool-chip was discovered with linear textured geometry ,hence reduce the cutting force accordingly over untextured tool . Kumar Mishra et al.[5] performance of untexture and circular dimple textured tools under vegetable oil based MQL, and alumina suspended DI water based nMQL medium on Ti6Al4V alloy. It was conclude that, even at high setting conditions also , textured tool with nano fluids were effectively ingresses at machined zone ,Consequently reduce the cutting force over untextured tool.Musavi et al.[6]investigation on surface roughness and 'V_b' of Al 7075 under untexture and

textured tool in dry and MQL environment in .Microgrooves efficiently act as storage sites and flow the coolant mist on rake face .Further ,optimization were performed for the outputs. In this aspect, author conclude that, low BUE and less adhesion work piece in texture geometry under MQL over untetxure respectively.Gajrani et al.[7]In field of metal cutting , AISI H-13, a significant reduction of output parameters were notices under textured tools at various cooling methods ,including MQL. Authors conclude that, coolant mist penetrated smoothly in to the cutting region in lesser time, which causes low in cutting temperature .Further , reduce cutting force simultaneously over untexture. Moreover , RSM was used to estimate cutting force respectively.Siavaih et al.[8]machined indices sensitively affected by the microgrooves with circular pit holes texture tool in machining of AISI304 under conventional cooling over dry cutting.Authour knowledge , microgrooves effectively store the coolant and dissipates the heat on tool-chip interface .Further cutting temperature and surface roughness reduced to 52% and 46% over dry cutting respectively. Sen et al.[9] under mql with nano silica and palm oil supplied in cutting of Inconel 690.It was discovered that, a noticeable enhancement of surface finish and mitigates of tool wear was gained at penetrate 1% silica palm oil respectively. Darshan et al.[10] dimple texture was fabricated on rake face and cutting experiments carried out Inconel 718 alloy under dry and solid lubricant-assisted MQL. At machined zone, cutting temperature was reduced by texture tool over untexture under solid lubricant-assisted MQL.Here, dimples with high-pressure air could enhance the heat transfer from the cutting edge respectively. Kulandaivel and Kumar [11] In view of more reduction of cutting zone temperature was reason for reduce the tool wear and surface roughness in textured tools over untextured tool under MQL assessment in cutting of Monel K500 alloy.Hao et al.[12] comparation of untextured and textured tools under MQL medium during cutting of studied the effect of Ti-6Al-4V alloy. From the literature, it was noticed that lyophilic/lyophobic wettabilities with textured tool significantly reduce the cutting force and tool wear over grroved tool and untextured tool respectively. As et al.[13] comparation of aluminum oxide nanofluid and copper oxide Nano fluids under MQL environment with machinability of AISI 4340 alloy steel. As per survey , due excellent property of thermal conductivity, copper oxide Nano fluids has removes more heat from the machined zone over aluminum oxide nano fluid under MQL .consequently reduce the cutting force up to 357N respectively.Mayurkumar Makhesana et al.[14]Investigation of Machinability indicators on Ti-6Al- 4V titanium alloy under various cooling techniques and compares the results , MQL with Hexagonal Boron Nitride (hBN) nanoparticles ,dry ,flood and MQL methods under textured tools. Authors knowledge, through effective heat transfer, flank wear reduced maximum of 29% under textured with MQL hBN respectivily.other hand, under MQL, coolant mist was effectively supplied to machined interface, maximum reduction of surface roughness up to 13.49% under MQL with textured tool over other cooling techniques respectively. P.Sivaiah et al.[15]comparation of so developed textured tools , circular pit holes (T1) and circular pit holes with linear grooves (T2) under dry and MQL conditions while cutting of AISI 316.under T2 tool with MQL ,maximum reduction of 28,17 and 31% for mitigation of cutting temperature , flank wear and surface roughness over T1 under dry cutting. Thus ,current work focused on effect of developed texture tool and untextured tool on machinability indices in cutting of EN24 Alloy steel by varying the cutting velocity ,feed and depth of cuts.

1.1 Materials and methods

Consider textured tool was developed by laser textured machine with dimensions of hole size 100µm, hole depth 100µm and space between two holes 200µm.The consider texture has improves the storage capacity of coolant mist circular holes .It was the reason for fabricate the texture on plain tool. The performance of textured tool was evaluated under MQL assisted cooling environment by using

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SINUMERIK 828D BASIC made by LMW SMARTURN CNC machine. Figure 1. Schematic view of (a) untextured tool (UN) and (b) circular pit hole texture (CT) with CNC machine set up. Sophisticated MQL equipment was developed with nozzle diameter 1mm to deliver the coolant at machined zone effectively. For the experimentation, cutting velocity are 110 and 137m/min ,feed rates are 0.1and 0.12mm/rev,depth of cuts are 1.0 and 0.2mm as cutting parameters .A 300mm length of EN24 alloy steel work piece with dimensions of (Φ 35 mm x 150 mm) was taken in account for the experimentation. Each experiment was repeat three times and changes the tool edge at every single pass. Cutting force was measured by lathe tool dynamometer.

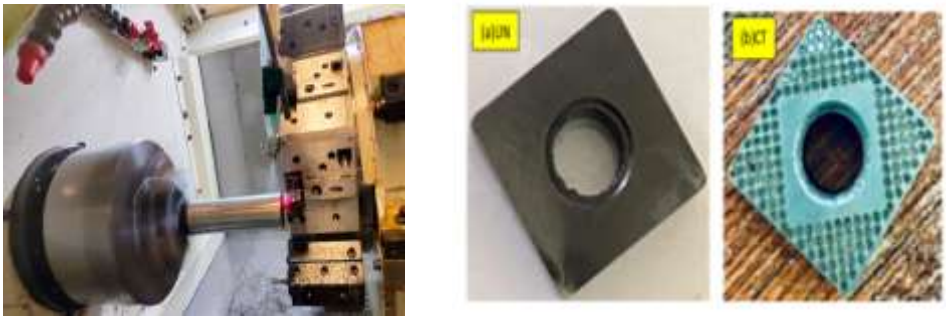

Figure 1. Schematic view of (a) untextured tool (UN) and (b) circular pit hole texture (CT).

Table 1. Chemical composition of EN 24 alloy steel (%)

C	Si	Mn	P	S	Mo	Cr	Ni	Fe
0.398	0.258	0.527	0.016	0.009	0.240	1.151	1.522	95.622

1.2 Results and Discussion

Influence of MQL - assisted cooling condition on cutting force with (a) UN tool and CT tools:

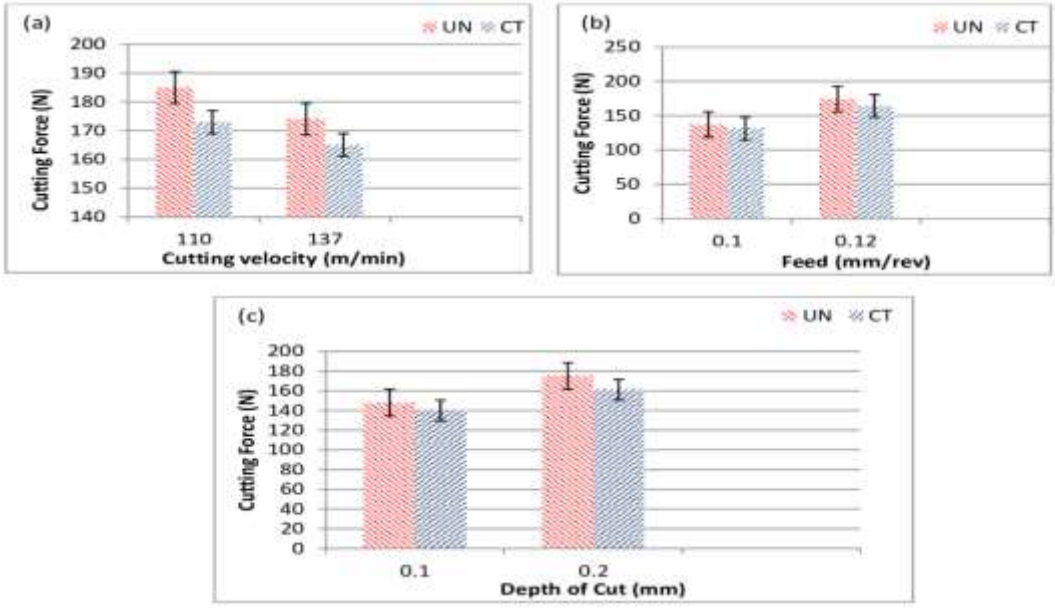

Figure 2. Effect of cutting force (F_f) , at cutting velocity 137m/min ,feed 0.12mm/rev and depth of cut 0.2mm (a)Untexture (UN) and (b)Textured tool (CT) under MQL cooling.

In turning operation process the tool and wok piece interaction create unwanted vibration and noise it causes the failure of tool edge. The cutting force is plays crucial role of precision, quality and performance of machining. In other words, contact and friction of the tools result in cutting forces. High cutting force should directly influence on machine structure, consequently, increases power consumption. At high setting conditions increase the MRR and friction at cutting zone. Nevertheless, the interaction of tool and work time is low; therefore, the cutting zone temperature increases. Consequently, causes thermal softening of work piece respectively. To overcome, efficient cooling supply needs to reduce the cutting force, accordingly. In current work measure the cutting force values by lathe tool dynamometer.Fig.2.(a) when cutting speed is increases ,less 'F_f' were noticed under CT with MQL. MQL , at a ' V_c' 110m/min , developed cutting force values of UN and CT are 185N and 173N,where 6.48% significant reduction was seen in CT. Moreover, compare to CT ,untextured tool 'F_f' increased at 137m/min as 165N-174N and reduce the 5.17% under MQL circumstance in . MQL reduce the cutting force around an average of 5.17% - 6.48% at varying cutting velocity values from 110 m/min – 137m/min respectively. Fig.2(b) increasing of feed rate values 0.1 -0.12 mm/rev ,cutting force increase more in UN over CT .Here , maximum feed value ,UN, developed more stresses consequent deflect work piece slightly. .Overall, MQL, up to maximum reduction 4.3%-5.74%was seen in CT over UN. Fig.2(c) varying depth of cut values from 0.1 - 0.2mm , under MQL ,UN, penetration of coolant mist was low at machined contact area ,therefore, more cutting temperatures and vibration of cutting tool was observed. CT, nearly reduce the cutting force value 5.41%-8%, accordingly. In this connection, overall MQL cooling method the minimum 'F_f' value was noted in developed tool as 140N.For all the cutting conditions,MQL gave positive results and a maximum of 8% reduction was noted under CT over UN.

1.3 Conclusions

A series of cutting operations of EN24 alloy steel were conducted with circular pit texture geometry on rake face at various cutting conditions of cutting velocity, feed and depth of cut with MQL mist. The fabricated circular pit holes increase the machinability indices effectively.

1. MQL technology effectively worked on textured tools over untextured tools .
2. UN tool, cutting forces were increased effectively due to deflection of work piece at higher cutting setting conditions over textured tools.
3. A minimum cutting force was identified under MQL as 131N and maximum reduction 8% in textured tool over UN tool.
4. As a further research, cutting experiments were carried at different textured geometry with increase of cutting condition values and further understand the machinability indices.

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