"EFFECT OF DIFFERENT MACHINING PARAMETERS ON DRY MACHINING"

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Abstract

The emergence of government legislations in environmental matters has lead to the minimization of use of cutting fluids in machining processes making the study of dry turning process important. Several researchers' state that the costs related to cutting fluids is frequently higher than those related to cutting tools. Considering the high cost associated with the use of cutting fluids and projected costs when the stricter environmental laws are enforced, alternatives have been sought to minimize or even avoid the use of cutting fluid in machining operations leading importance to the study of dry turning process. Dry machining is now of great interest and actually, they meet with success in the field of green (eco-friendly) manufacturing. Many plant managers know of the non-value added costs associated with flood coolants – part cleaning, frequent floor cleaning, absorbent mats, coolant additives such as biocides, chip cleaning, etc. With Near-Dry Machining (also known as Minimal Quantity Lubrication), there are no flood coolants. Just a small amount of atomized cutting fluid is applied directly to the cutting interface. Typical fluid consumption is less than 10 ml per hour per nozzle and the chips are dry to the touch (0.2% oil content). In this seminar report, focus is given on need, literature review, cost analysis between cutting fluids and tool used, ten commandments and latest trends dry machining.

I. Introduction:

Since 1980 a wealth of knowledge in machining has been obtained through the development of mechanistic models for machining processes. Based on a set of process conditions, these models can provide accurate prediction of the machining forces, surface error, surface finish and dynamic process stability. There have been numerous approaches proposed by large number of researchers to deal with the machining condition selection problem. Some of the optimization methods proposed use a various objective function, such as production time, production cost , cutting speed, feed, depth of cut, the tool-geometry selection, force variation, process stability etc.

The dry machining as the machining of the future has been reported that it can eliminate cutting fluids with the advancement of the cutting tool materials. The cutting performance of MQL machining is better than that of dry machining because MQL provides the benefits mainly by reducing the cutting temperature, which improves the chip–tool interaction. MQL reduced the cutting forces by about 5–15%. MQL with the present technique has reduced flank wear and hence is expected to improve tool life. Surface finish and dimensional accuracy improved mainly due to reduction of wear and damage at the tool tip by the application of MQL [N.R. Dhar, M.T. Ahmed, S. Islam 2007]. The cutting performance of cryogenic machining is better than that of conventional machining with flood cutting fluid supply. Cryogenic cooling by liquid nitrogen jets provided lesser tool wear, better surface finish and higher dimensional accuracy as compared to dry and wet machining. [N.R. Dhar , 2007].

The study results suggested that cooling air and cooling air and minimal quantity lubrication (CAMQL), respectively, presented 78% and 124% improvement in tool life over dry cutting when finish turning Inconel 718 at a cutting speed of 76 m/min. Cooling air gave 130% improvement in tool life over dry cutting when high speed milling AISI D2 tool steel at a cutting speed of 175 m/min. [Y. Su, N. He, 2007]. An outstanding outcome of the experiment is that the solid lubricant provided better surface finish compared to machining using cutting fluids or dry machining. Solid lubricants are not forbiddingly expensive, due to their reuse strategies. The results clearly demonstrate the economic viability of solid lubricants in the context of increasing industrialization.[D. Nageswara Rao and P. Vamsi Krishna, 2007].

In this study, small quantities of free-machining elements were added to a hypoeutectic Al–Si cast alloy to evaluate the effect on dry machining. Four elements, Pb, Bi, In, or Sn, were tested at concentrations of 0.1–1 wt. %. The improvement in dry machinability was striking, increasing from a few holes to thousands of holes drilled with a single drill. Power consumption was decreased by at least 20%, drilling temperatures remained low and, in general, machining approached that possible with wet machining. [J.M. Dasch, C.C. Ang, C.A.Wong, R.A.Waldo, D. Chester, Y.T. Cheng, 2008], conclusions can be drawn for effective dry machining of high-purity graphite in order to achieve a better surface finish and improve the dimensional accuracy For a low feed rate, it increases the flank wear of tool but improves the surface finish quality, The implementation of DOE not only provides an effective guideline through the regression models but also enhances the efficiency of dry machining of high-purity graphite by optimizing the cutting parameters.[Yung-Kuang Yang, Ming-Tsan Chuang, 2009].

Surface roughness (Ra) values are increasing with increase in speed, depth of cut is not influencing much on roughness values, but the roughness values are varying nonlinearly with increase variation of feed. [M. V. R. D. Prasad, G. Ranga Janardhana and D. Hanumantha Rao 2009], The cutting forces in dry cutting of hardened steel with SLT-1, SLT-2 and SLT-3 tools were reduced compared with those of the SLT-5 conventional tool. The SLT-1 self-lubricating tool, The cutting forces in dry cutting of hardened steel with self-lubricating tool, The micro-holes in the rake or flank face did not weaken the tool's properties for the self-lubricating tools except the SLT-3, tool according to the stress distribution analysis by FEA. [Song Wenlong, Deng Jianxin, Zhang Hui, Yan Pei, Zhao Jun, 2010].

II. Analysis of different process parameters:

a. Micromole implementation on Cemented carbide tools for better cooling:

Cemented carbide was selected as a cutting tool material for this study. Composition, physical, and mechanical properties of this tool material are listed in Table 1. Four micromoles were fabricated in the appropriate position on the rake face or the flank face close to the main cutting edge by micro-Electronic Discharge Machining (EDM). The diameter of the holes is about 150 μm, and the depth is about 400 μm. MoS2 solid lubricants were then filled into the micro-holes so as to form self-lubricating tools. Fig. shows the optical morphology of self-lubricating tools with four micro-holes embedded without MoS2 (SLT-3) and with MoS2 (SLT-1) on the rake face. The optical morphology of tools with four micro-holes embedded without MoS2 (SLT-4) and with MoS2 (SLT-2) on the flank face are shown in Table 2 exhibits the scheme of self-lubricating tools with micro-holes embedded with and without MoS2 on the tool face and conventional tools.

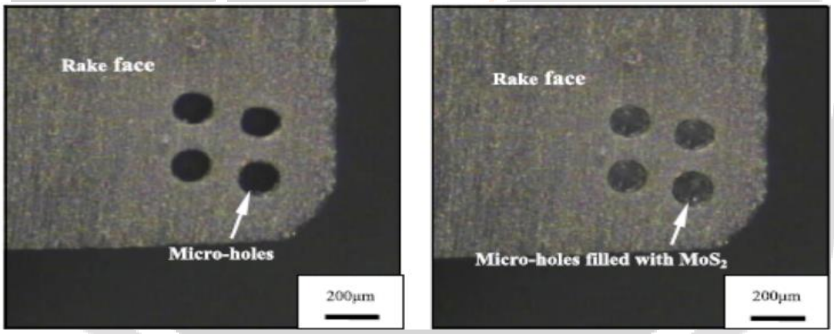


Fig.1 Micro-holes in the rake face of the carbide tool filled: (a) without MoS2 (SLT-3); (b) with MoS2 (SLT-1).

b. Tools wear Protection using cooling air and minimal quantity lubrication (CAMQL):

Nose wear was the predominant tool failure mode observed when finish turning Inconel 718 under all the cooling/lubrication conditions employed. Fig. 5 shows nose wear curves when machining Inconel 718 with coated carbide inserts under various cooling/lubrication conditions. Nose wear increased rapidly with the cutting time under dry cutting condition. However, nose wear increased at a lower rate under cooling air and CAMQL conditions, especially when using CAMQL. The end of tool life was

considered at 0.2mm nose wear. When nose wear reached 0.2 mm, the cutting time for the various cooling/lubrication conditions was 2.058, 3.662 and 4.608 min for dry cutting, cooling air and CAMQL, respectively. Thus, cooling air and CAMQL, respectively, gave 78% and 124% improvement in tool life over dry cutting when finish turning Inconel 718 at a cutting speed of 76 m/min.

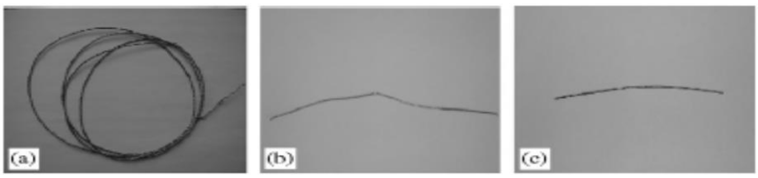


Fig 2 Chip shape for finish turning Inconel 718 under cooling/lubrication conditions (a) Dry

cutting, (b) cooling air, & (c) CAMQL

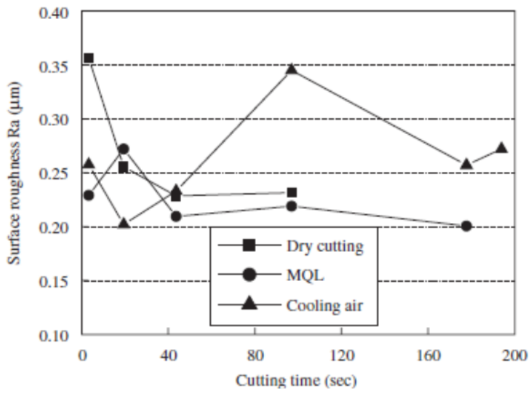


Fig. 3 Surface roughness against cutting time when high speed milling AISI D2 tool steel under various cooling/lubrication conditions.

C. Analysis of Results :

In any process there are two important factors which will control the process.

1) One is control factor, these are process variables like speed feed, temperature, flow etc, by varying these parameters one can study the influence of these parameters on response(Output, ex: surface roughness, dimensional accuracy, solidification time, stability etc.,)

2) The other factor which controls the process is known as noise which is difficult to identify and control individually, it is hidden factor and it is due to the influence of one or more process parameters

3) A measure of robustness that can be used to identify the control factor settings that minimize the effect of noise on the response. This can be obtained by calculating separate signal-to-noise (S/N) ratio for each combination of control factor levels in the design.

D. Experimental investigation for surface roughness:

Design of experiments concept was used for planning the necessary experimentation

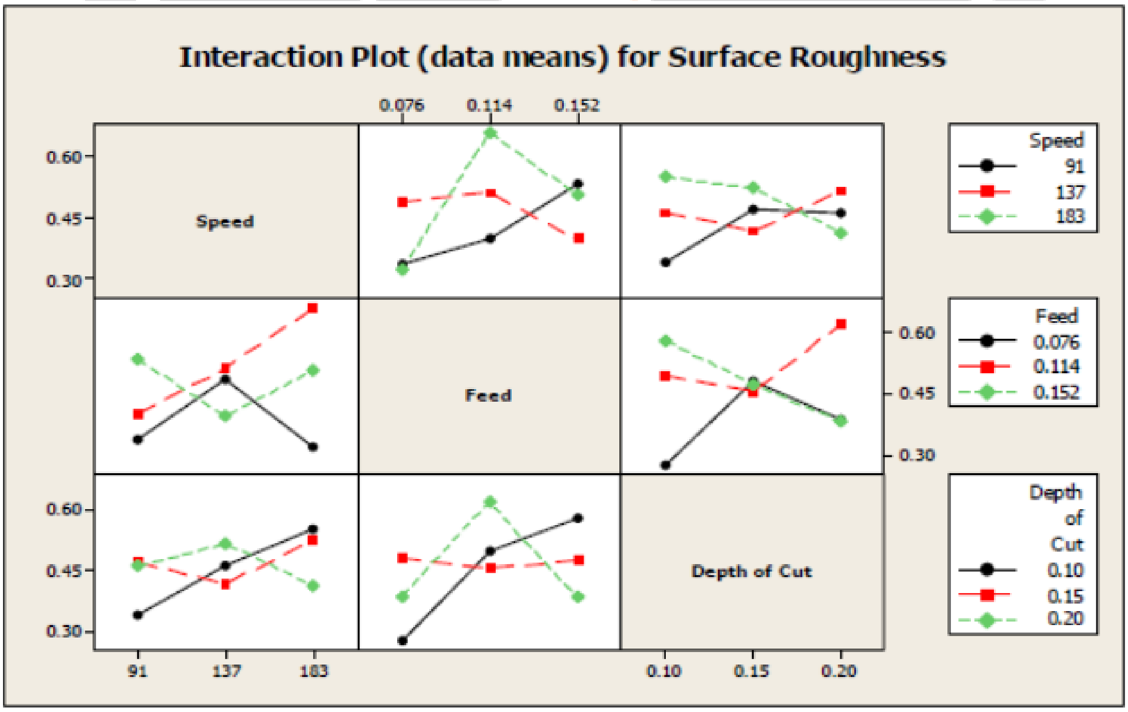


Fig.4 Main effects plot for surface roughness

The data was further analyzed to study the interaction among process parameters and the main effects plot and interaction plots were generated and shown in Figures 5, respectively. Similarly contour plots are plotted surface roughness as output response and other, 6 and 7, respectively

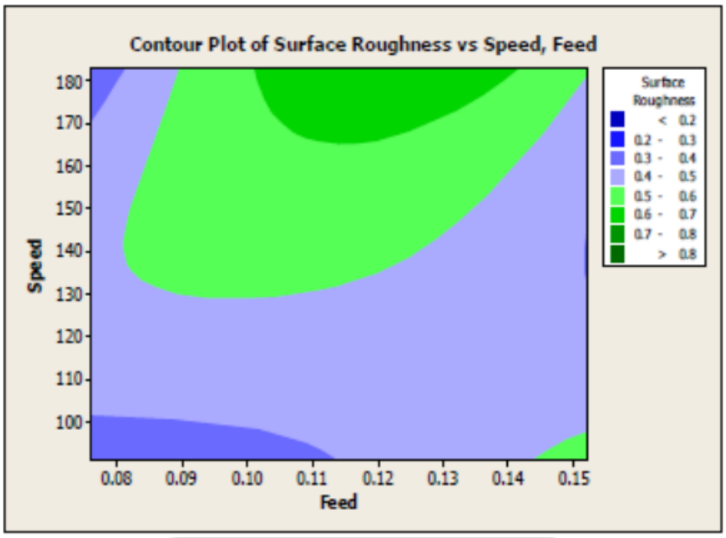


Fig.5 Contour plot for surface Roughness vs speed and feed

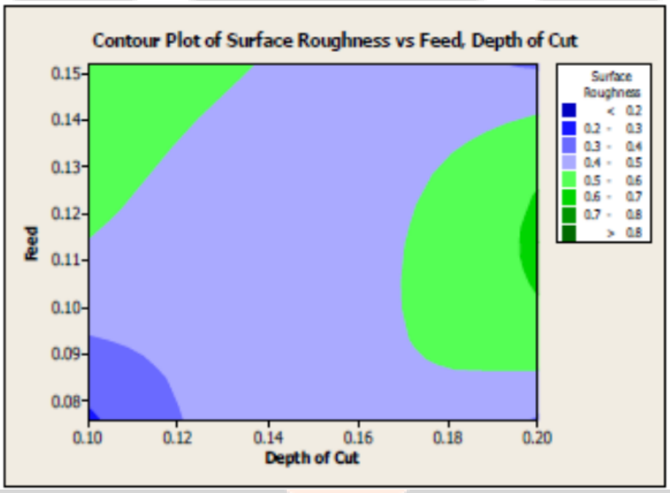


Fig.6 Contour plot for surface Roughness vs feed & depth of cut

E. Experimental investigation on coated carbide insert dry, wet and cryogenic cooling conditions.:

For the present experimental studies, AISI-4037 steel bar (j125mm_760 mm) was turned in a high-power rigid lathe (Lehman Machine Company, St. Louis, USA, 15hp) by coated carbide insert at industrial speed-feed combinations under all dry, wet and cryogenic cooling conditions.

Table 1
Experimental condition

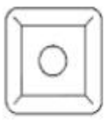
Machine tool	: High power rigid lathe, USA, 15 hp	
Work specimens		
Materials	: AISI-4037 steel (C-0.37%, Mn-0.80%, P-0.035%, S-0.04%, Si-0.20%, Cr-0.25%)	
Size	: Φ125 × 760 mm	
Cutting tool	: Coated carbide, Sandvik Coating: TiCN + Al_2O_3  SNMG 120408-26	
Tool holder	: PSBNR 2525 M12 (ISO specification), Sandvik	
Working tool geometry	: Inclination angle	: −6°
	Orthogonal rake angle	: −6°
	Orthogonal clearance angle	: 6°
	Auxiliary cutting edge angle	: 15°
	Principal cutting edge angle	: 75°
	Nose radius	: 0.8 mm
Process parameters		
Cutting velocity, V_c	: 165, 194, 239 and 264 m/min	
Feed rate, S_o	: 0.10, 0.13, 0.16 and 0.20 mm/rev	
Depth of cut, t	: 1.5 mm	
Environment	: Dry, wet and cryogenic cooling by liquid nitrogen	

Fig.7: Experimental Condition

The photographic view of the experimental setup is shown in Fig.7(a) For cooling and lubrication, liquid nitrogen (196 1C) in the form of thin but high speed was impinged from a specially designed nozzle along the cutting edge of the insert, as indicated in Fig. 7 (right), so that the coolant reaches as close to the chip–tool and the work–tool interfaces as possible. The liquid nitrogen jet has been used mainly to target the rake surface and flank surfaces along the auxiliary cutting edge and to protect the auxiliary flank to enable better dimensional accuracy.

F. Experimental setup & results analysis of turning steel with liquid nitrogen:

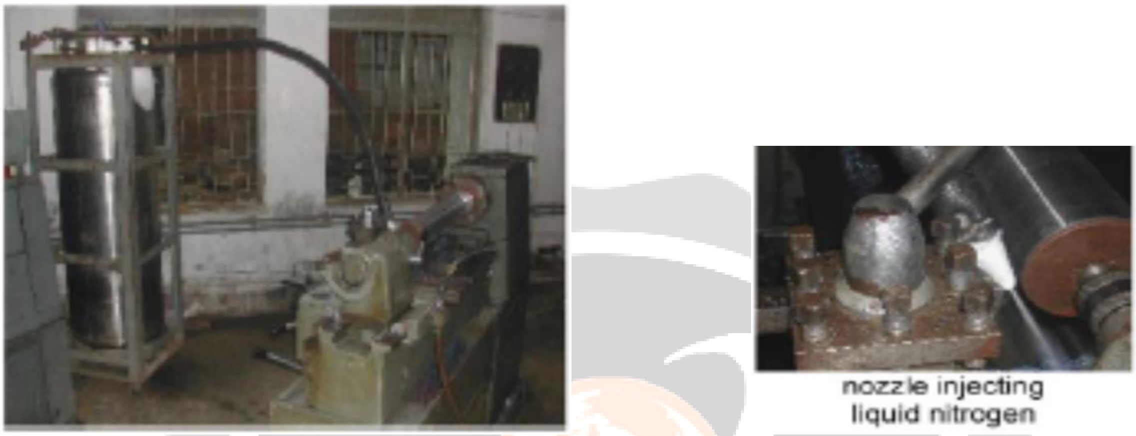


Fig. 8. Photograph view of the experimental set-up for turning Nozzle injection liquid nitrogen steel with liquid nitrogen.

Experimental results and discussion During machining any ductile materials, heat is generated at the (a) primary deformation zone due to shear and plastic deformation, (b) chip–tool interface due to secondary deformation and sliding and (c) work–tool interfaces due to rubbing. All such heat sources produce maximum temperature at the chip–tool interface, which substantially influence the chip formation mode, cutting forces and tool life. Therefore, attempts are made to reduce this detrimental cutting temperature

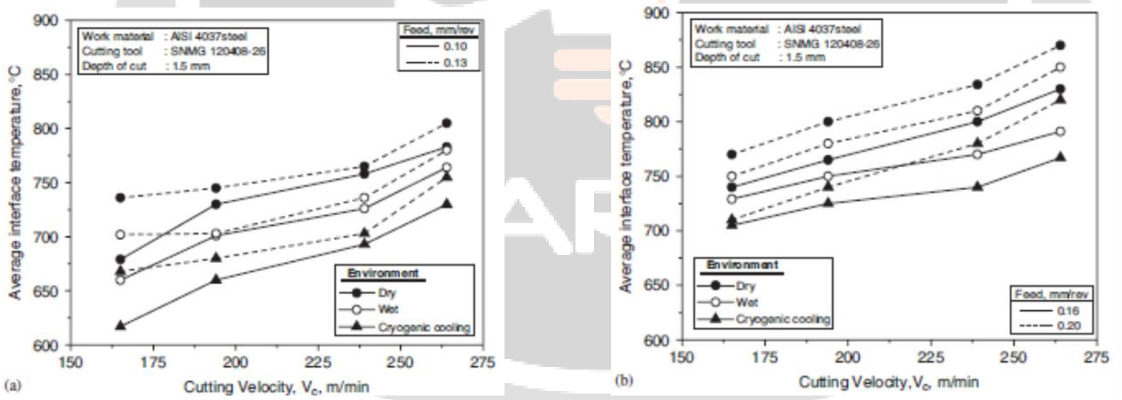
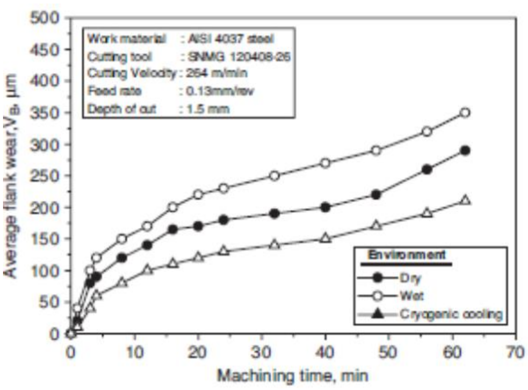


Fig.9 Variation of average chip tool interface Vc with different environments at lower and higher feed rates



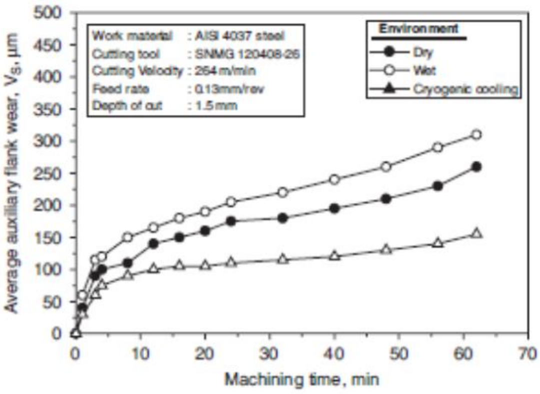


Fig.10 Growth of Vb with machining time under Diffrernt environments at cutting velo.264m/min

Growth of Vs with machining time under Different environments at cutting velo.264m/min

The life of carbide tools, which fail by wearing, is assessed by the actual machining time after which the average value (VB) of its principal flank wear reaches a limiting value of 0.3 mm. Therefore, attempts should be made to reduce the rate of growth of flank wear (VB) in all possible ways without much sacrifice in MRR. Fig. 3 clearly shows that average flank wear, VB decreased substantially by cryogenic cooling. Crater wear of carbide tools in machining steels particularly at higher Vc and So occurs by adhesion and diffusion as well as post abrasion, whereas flank wear occurs mainly by microchipping and abrasion and the increase in Vc and So adhesion and diffusion also come into picture due to intimate contact

The cause behind reduction in VB observed may reasonably be attributed to substantial reduction in the cutting temperature by cryogenic cooling, particularly the jet impinged along the main cutting edge that helped in reducing abrasion wear by retaining tool hardness and also adhesion and diffusion types of wear that are highly sensitive to temperature. Because of such reduction in the rate of growth of flank wear, the tool life would be much higher if cryogenic cooling is properly applied. Auxiliary flank wear (VS), though occurs less intensively, also plays a significant role in machining by aggravating dimensional inaccuracy and roughness of the finished surface. It appears from Fig. 4 that auxiliary flank wear (VS) has also decreased size due to proper temperature control under cryogenic cooling.

III. **Conclusion**:

After go through report overall advancement in machining is becomes developed in respect of cost association. Moreover, coolants give rise to environmental problems related to waste disposal. As the costs for waste disposal increase, industries will be forced to implement strategies to reduce the amount of coolants they use. Dry machining requires suitable measures to compensate for the absence of coolants.

In different operations is go through the deep study &found conclusions such as Open faced operations such as milling and boring can be effectively run dry. In contrast, closed-face machining operations such as drilling and tapping cannot be efficiently run dry because the metal chip remains in close proximity to the tool/work piece interface. To economize the machining operations instead of 100% dry machining near dry machining, cryogenic cooling, solid lubrication, refrigerated air cooling are best solutions.

IV. REFFERENCES

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