P. A. Thakare / IOSR Journal of Engineering (IOSRJEN)
www.iosrjen.org ISSN : 2250-3021
Vol. 2 Issue 1, Jan.2012, pp. 007-010

Green Technology - Use Of Water Mist Jet - The Next Milestone for Machine Shops Cutting Fluids

P. A. Thakare
Faculty of Electrical & Mechanical Engineering
College of Military Engineering, Pune Maharashtra 411031(India)

ABSTRACT: Cutting fluids are widely used in machine operations**.** Machining is a major secondary manufacturing process in the metal cutting industry. Any machining process for its implementation needs to be technologically acceptable, feasible and economically viable. The fourth dimension that has been a great concern of modern industries and society is environment-friendliness. In India 50000 Kilolitre of metal working fluids produced from mineral oil are consumed annually. During turning operations, high temperatures are produced. Such high temperatures often lead to several problems like a large heat affected zone, high tool wear, change in hardness and in the microstructure of the work piece, burning, its consequences and micro cracks. Application of cutting fluids in conventional method reduces the above problem to some extent through cooling and lubricating the cutting zone. But in this process the cooling rate is low. For this reason, mist application technique has become the focus of researchers and technicians in the field of machining as an alternative to the traditional flood cooling. The concept of mist application of cutting fluid is referred to as **'GREEN CUTTING'**. The minimisation of the requirement of cutting fluids leads to economical benefits, and environmental friendly machining. In this work, attempts have been made to develop a mist application device to apply the cutting fluid for turning operations upon mild steels. Our experiment is to determine the cutting forces, surface finish, temperature variation and distribution by using different tool material inserts at different rake angles and constant feed rate. The working principle of green cutting is the use of mist of water at high pressure (up to 60 to 70 bar), after passing air through supersonic nozzles, to remove chips, reduce the machining temperatures during machining. Cutting fluids represent a significant manufacturing waste stream and health hazard Reduction or eliminating of cutting fluids requires a fundamental understanding of the role that the fluids play in heat generation and heat transfer.

Keywords: Dry Machining, Flood Cutting, Green Cutting, Mist Cooling.

I. INTRODUCTION Modern day world machining processes aim at better machining processes, higher machining efficiencies, reduced machining costs, reduced tool wear and reduced environmental hazards. Conventionally cutting fluid is used to cool and lubricate the cutting process, thereby reducing tool wear and lengthening tool life. However conventional emulsion cooling has inherent health and environmental problems. Conventional cutting fluid is an environmental contaminant and the government has strict regulations limiting the dumping of cutting fluid water. Promising alternatives to conventional flood coolant applications are the minimum quantity lubrication (known as MQL) and dry machining technologies. The share of the cost of coolant in any machining process is as shown in the fig 1.

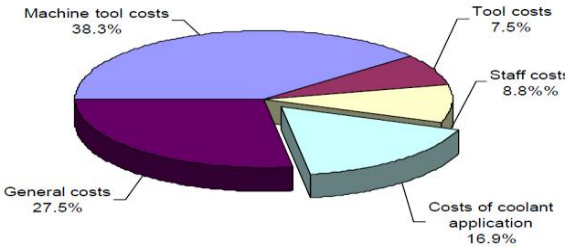

Fig 1 Cost distribution in machining

There are the five major types of the cutting fluids available today:

1. Straight Cutting Oils
2. Water Emulsifiable Oils
3. Synthetic Fluids
4. Semi-Synthetic Fluids
5. Liquid Nitrogen(Cryogenic cooling)

The green cutting technology is an under research proposal that aims to replace the use of oil coolants with supersonic water mist jets, during machining operations. It has been proposed to economically and efficiently perform cutting operations upon hard metal alloys like aero-engine alloys and hardened steel. This technology can be applied to all machining operations like cutting, drilling, boring, reaming etc. It takes into consideration the economic aspects of the industrial requirement and is a low cost, high efficiency and environmental friendly technology. The characteristics of the green cutting technology are as follows:

1. Use of pressurized water for mist generation
2. High efficiency
3. Employability on metals
4. Environmental friendliness

Vol. 2 Issue 1, Jan.2012, pp. 007-010

5. Compactness and economics

Flash evaporation occurs when water is forced through micro nozzles, creating a super fine mist. The smaller each water droplet, the more surface area per liter of water and the more effectively the water evaporates. As the super-fine water droplets are introduced into the atmosphere, they quickly absorb the heat present in the environment and evaporate, hence the air is cooled.The detrimental effects of the cutting fluids include the cost of the cutting fluid system [1], i.e. the fluid itself, pumping systems, collection and filtering system, storage and disposal, and sometimes a re-circulating system etc; the physiological effects on the operator, namely, toxic vapours, unpleasant odours, smoke fumes, skin irritations (dermatitis) [2].To design machining processes that reduce formation of harmful cutting fluid vapours was studied by Y K Siow, S.l.Yang, and J.l.sutherland. And later by Md. Abdul Hasib [3] cooling by Mist applications.

II. EXPERIMENTALSETUP AND PROCEDURE

The beneficial role of water jet mist cooling has already been established. The aim of the present work is primarily to explore and evaluate the role of such mist cooling on machinability characteristics (temperature, cutting force and surface finish) and compare its characteristics with dry machining and flood machining for two tool materials ((High speed steel)HSS and (Tungsten carbide) WC. The experimental conditions under which the machining tests have been carried out are briefly given in TABLE [1]. The speed of rotation (N) and feed rate (s) have been selected based on the data given in Manufacturing Data book [6] for Mild Steel work piece material and industrial practices. Depth of cut, being less significant parameter, was kept fixed to only 0.5 mm, which would adequately serve the present purpose.

Table 1: Machining Parameters

PARAMETERS	VALUES
Feed	0.37 mm/rev
Cutting speed (Work piece)	190 rpm
Depth of cut	0.5mm
Rake angle	10, 20, 20 degree
Nose radius	0.4mm

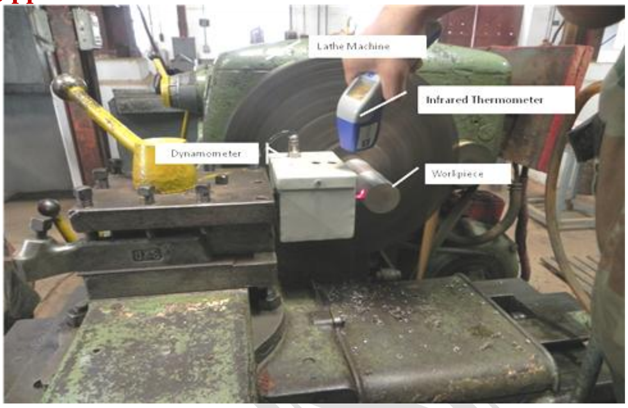

Fig 2: Experimental setup

Fig3: Machining using Mist Cooling

The following items were used in the experimental setup:

Table 2: Items and their make

ITEM	MAKE
Pump	WUL-X WM 10005-6 Fogging pump
Nozzle	(diameter)Ruby crystal type
Dynamometer	S P ENGG Piezo electric type
Lathe machine	G Swift(SENS Haliforx England)
Thermometer	TIF 7610 Infrared type
WC tool	10% cobalt (Miranda company)
HSS tool	Miranda tool
Workpiece	Mild steel (Black)

Since there was no evidence of measuring the temperature in the previous experiments conducted by various labs, the primary goal of our study was to measure the forces, temperature and the surface finish of the hard material alloys after machining and also to show the comparative study between liquid coolants, the use of water mist and dry machining at different rake angles.

Experimental procedure:

1) In the first phase work piece (hard metal alloys) was machined by high speed steel and then subsequently with

Vol. 2 Issue 1, Jan.2012, pp. 007-010

tungsten carbide , both tools at 10 degree rake angles , using dry machining , flood machining and mist cooling.

2) In the second phase workpiece and keeping all the other components same the experiment was conducted at 20 degree rake angle.

3) In the third phase all tools were ground to 30 degree rake angle and the same set of experiment was repeated.

The infrared thermal gun was used to measure the temperature; lathe tool dynamometer gave the readings for cutting forces. The work pieces were later send to lab for surface finish testing.

To prevent the work output of mist cooling from rusting the work pieces were covered with thin layer of oil.

The infrared thermometer was held at distance of 5 cm manually from the chip tool interface. After one set of reading the workpiece was left to attain room temperature and then readings were taken for same machining parameters.

III. RESULTS

The following set of readings of surface finish, temperature, cutting force and feed force were taken during the course of experiment **for WC tool and HSS cutting tool** :-

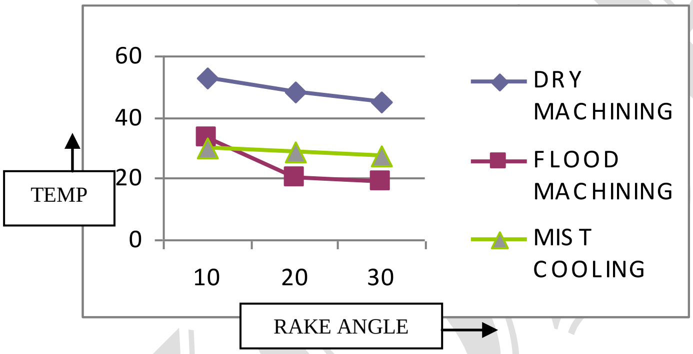

Fig 4: TEMP V/S RAKE ANGLE GRAPH (WC TOOL)

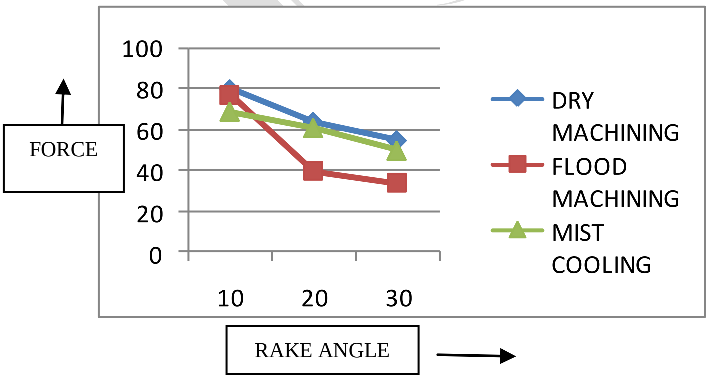

Fig 5: CUTTING FORCE V/S RAKE ANGLE GRAPH (WC TOOL)

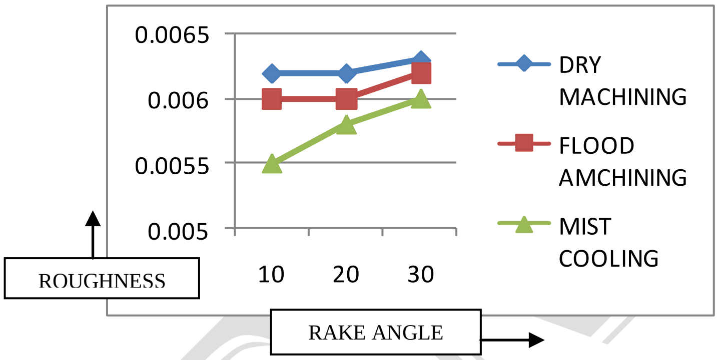

Fig 6: SURFACE ROUGHNESS V/S RAKE ANGLE GRAPH (WC TOOL)

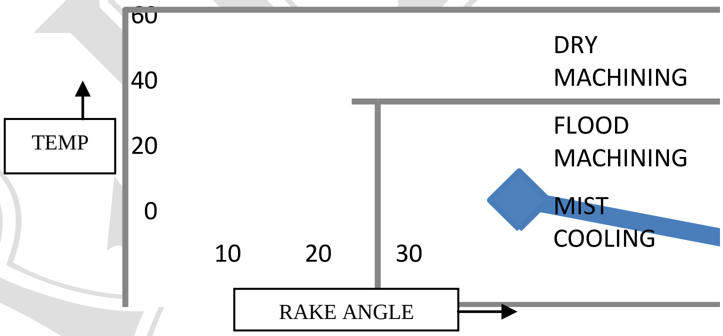

Fig7: TEMP V/S RAKE ANGLE GRAPH (HSS TOOL)

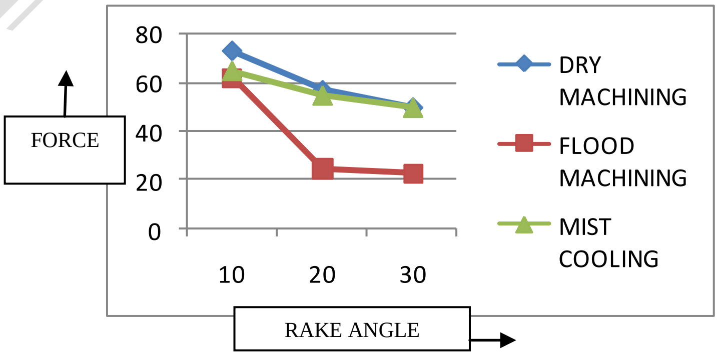

Fig 8: CUTTING FORCE V/S RAKE ANGLE GRAPH (HSS TOOL)

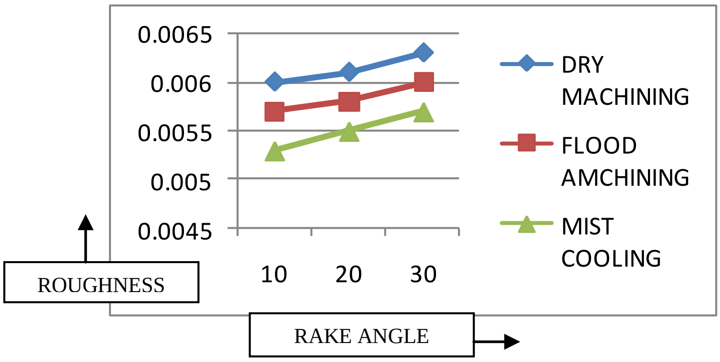

Fig 9: SURFACE ROUGHNESS V/S RAKE ANGLE GRAPH (HSS TOOL)

IV. DISCUSSION

1) Temperature and cutting forces decreases with increase in rake angle.
2) Dry machining gives the highest temperature followed by mist cooling. Flood machining gives the least temperature.
3) Water as mist coolant acted as ineffective chip breaker.
4) Dry machining gives the maximum cutting forces followed by mist cooling. Flood machining proved most effective.
5) Temperature developed with HSS tool was generally less than WC tool.
6) Mist cooling at 10 degree rake angle gives least temperature, least cutting forces and best surface finish.
7) More uniform and continuous chip are formed During mist machining as compared to dry and flood machining, though mist did not prove to be effective chip breaker.
8) Water jet mist gives the best surface finish at all Rake angles.

V. CONCLUSION

- As it does not use any chemical coolants, which are toxic in nature, this method of machining is eco friendly. It is also cheaper as compared to other methods.
- Magnitude of the frictional forces are greatly reduced, thus less heat is generated. Thus temperature at chip tool interface is greatly reduced and better surface finish is achieved.
- Workpiece need not be treated or cleaned after the machining operation as the water vaporises easily. Thus, the waste metal of the workpiece can be recycled easily in case of mist machining operation as compared to the workpiece material machined using other chemical coolants.
- An internet- based Cutting fluid Evaluation Software Test bed (CFEST developed by MT-AMRI universities) can be used to get the quantitative output data regarding environmental impact and health hazard associated with the cutting fluid. This software test bed provides an analytical cutting fluid evaluation tool for manufacturing practitioners to compare and select cutting fluids for better process performance while minimizing environmental and health impact.

VI. REFRENCES

[1] Aronson, R. B. 1995. Why Dry Machining. Manufacturing Engineering. *Vol. 114, pp. 33-36*

[2] Bennett, E. O. 1983. Water Based Cutting Fluids and Human Health. *Tribology Int .Jr,1983*

[3] Md. Abdul Hasib, Abdullah Al-Faruk, Naseem Ahmed. Mist Application of Cutting Fluid

[4] Dhar, N. R., Kamruzzaman, M., Khan, M. M. A. and Chattopadhyay, A. B. 2006. Effects of Cryogenic Cooling by Liquid Nitrogen Jets on Tool Wear, Surface Finish and Dimensional Deviation in Turning Different Steels. *International Journal of Machining and Machinability of Materials (IJMMM), 2006.*

[5] Davud C Graham, Ken Saucier- Effectiveness of cooling system by using jet type nozzle, *Higgins grinding technology centre, February 2007 volume 59.*

BOOKS:

[6] *Manufacturing Process for engineering materials by Serope Kalpakjian and Steven R. Schmid. Fifth edition- 2011.*

VII. ACKNOWLEDGEMENT

For successful completion of the work the authors would like to convey his special regards to foreman, entire working staff at FE/M workshop. The research was funded by College Of Military Engineering (Pune). He is also grateful to Kasaka Laboratories for helping us with results of surface roughness.

VIII. AUTHOR

Mr. P. A. Thakare is working as Assistant Professor with mechanical Engineering department of College of Military Engineering. His research areas include Production Technology, Manufacturing, micro fabrication and Industrial Engineering. He already has many papers published to his name.