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EFFECTS OF THREE DIFFERENT CUTTING FLUIDS IN THE TURNING OF MILD STEEL AISI1008

Zeenat Fatima[1], Mohd.Zafaruddin khan[2], Dr. Shahnawaz Alam[2]
Department of Mechanical Engineering Integral
University, Lucknow, India

Abstract— **This paper investigates the effect of various cutting fluid in the cutting and machining operation. Cutting action could be improved by the use of solids, liquids, emulsions or gases in the machining process. In all cutting and forming operations high temperatures are developed due to friction and unless the temperatures and pressures are controlled, the surfaces in contact may adhere to each other. In the present work, study has been done to see the effect of three cutting fluids during turning of mild steel (AISI1008).**

Index Terms— **Turning, Cutting Fluids, Mild Steel, Temperature, Minimum Quality of Fluid.** *(key words)*

I. INTRODUCTION.

Since the beginning of the 20th century, when F.W. Taylor used water for the first time to cool the machining process and concluded it increased tool life, a large variety of cutting fluids has been used with this and other purposes. However, in the last decade a lot has been done aiming to restrict the use of cutting fluids in the production, due to the costs related to the fluids, ecological issues, and human health and so on[1]. To minimize the use of cutting fluid, two techniques have been intensively experimented: cutting without any fluid (dry cutting, also known as ecological machining) and cutting with a minimum quantity of fluid (MQF), where a very low amount of fluid is pulverized in a flow of compressed air [1]. When cutting metals and alloys most of the energy required to form the chips is converted into heat. Therefore, the temperatures generated in the cutting zone are an important factor to take into consideration. This factor is of a major importance to the performance of the cutting tool and quality of the work piece [2]. Temperature in the cutting zone depends on contact length between tool and chip, cutting forces and friction between tool and work piece material. A considerable amount of heat generated during machining is transferred into the cutting tool and work piece. The remaining heat is removed with the chips. The highest temperature is generated in the flow zone. Therefore, contact length between the tool and the chip affects cutting conditions and performance of the tool and tool life [3-4]. For the improvement of cutting performance, the knowledge of temperature at the tool-work interface with good accuracy is essential. Due to the nature of metal cutting, it is not possible to measure temperature precisely in the cutting zone Because of nature of the metal cutting, determination of internal temperatures on the cutting tool are very difficult. For measuring of this temperatures generated in the cutting zone, several methods have been developed. Calorimetric method, thermocouple method, infrared photographic technique, thermal paints and PVD technique are some of them [5]. Cutting fluids play a significant role in machining operations and impact shop productivity, tool life and quality of work. Cutting fluids can be applied in the machining process in a number of different ways. The most common is flood application, where a large volume of fluid is pumped to the metal removal interface. The fluid is collected and then reused many times. Another method, Micro-lubrication, provides fluid to the cutting interface in the form of a mist, providing the lubrication effect Also related to the method of fluid application are the concepts of dry (no metal removal fluid used), near-dry, and semi-dry machining In this study the flood application will be used to compare the performance of the wet application. For low speed machining operations, lubrication is a critical function of the cutting fluid. Cooling is not a major function of the cutting fluid as most of the heat generated in low speed machining can be removed by the chip. For high speed machining operations, cooling is the main function of the cutting fluid, as the chip does not have sufficient time to remove the generated heat. The lubrication effects of the cutting fluid in high speed machining operations are also limited. The machining processes have an important place in the traditional production industry. Selection of suitable machining parameters like cutting speed, feed rate and depth of cut according to cutting tool and work piece material will result in longer tool life, better surface finish and higher material removal rate [6].

II. MACHINING

Turning is a widely used machining process in which material is removed using a single-point cutting tool on to a rotating cylindrical component. Material removal takes place in the form of chips from the surface of a rotating cylindrical component. The turned component produces some amount of surface roughness, which is an important parameter, which influences its service performances [7] such as friction, lubrication, wear, thermal resistance, electrical resistance, fluid dynamics, noise & vibration Turning process is shown in Fig. 1. Various parameters like cutting speed, feed rate, depth of cut, machine tool, cutting tool geometry, and component material all have an influence on the achievement of desired product quality and surface roughness values at an acceptable cost.

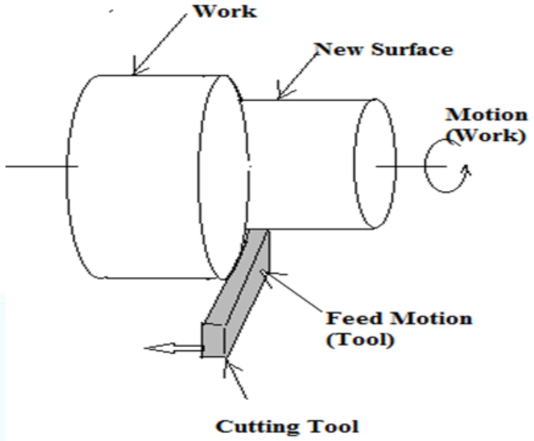

Fig.1 cutting tool operation

III. MILD STEEL

Mild Steel is a type of steel that contains only a small amount of carbon and other elements. It is softer and can be shaped more easily than higher carbon steels. It also bends a long way instead of breaking because it is ductile. It is used in nails and some types of wire; it can be used to make bottle openers, chairs, staplers, staples, railings and most common metal products. Its name comes from the fact it only has less carbon than steel.

Some mild steel properties and uses:

- Mild steel has a maximum limit of 0.2% carbon. The proportions of manganese (1.65%), copper (0.6%) and silicon (0.6%) are approximately fixed, while the proportions of cobalt, chromium, niobium, molybdenum, titanium, nickel, tungsten, vanadium and zirconium are not.
- A higher amount of carbon makes steels different from low carbon mild-type steels. A greater amount of carbon makes steel stronger, harder and very slightly stiffer than low carbon steel. However, the strength and hardness comes at the price of a decrease in the ductility of this alloy. Carbon atoms get trapped in the interstitial sites of the iron lattice and make it stronger.
- What is known as mildest grade of carbon steel or 'mild steel' is typically low carbon steel with a comparatively low amount of carbon (0.16% to 0.2%). It has ferromagnetic properties, which make it ideal for manufacture of many products.
- The calculated average industry grade mild steel density is 7.85 gm/cm3. Its Young's modulus, which is a measure of its stiffness, is around 210000 MPa.
- Mild steel is the cheapest and most versatile form of steel and serves every application which requires a bulk amount of steel.
- The low amount of alloying elements also makes mild steel vulnerable to rust. Naturally, people prefer stainless steel over mild steel, when they want a rust free material. Mild steel is also used in construction as structural steel. It is also widely used in the car manufacturing industry.
- Mild steel is used in almost all forms of industrial applications and industrial manufacturing. It is a cheaper alternative to steel, but still better than iron.

IV. HIGH SPEED STEEL

The term `high speed steel' was derived from the fact that it is capable of cutting metal at a much higher rate than carbon tool steel and continues to cut and retain its hardness even when the point of the tool is heated to a low red temperature. Tungsten is the major alloying element but it is also combined with molybdenum, vanadium and cobalt in varying amounts. Although replaced by cemented carbides for many applications it is still widely used for the manufacture of taps, dies, twist drills, reamers, saw blades and other cutting tools.

In this paper mild steel is used as work piece and tool is a single point cutting tool made up of high speed steel and the turning operation is performed on a lathe machine having different lathe speed taken into account.

Three different speeds of lathe are taken as shown in table 1

Table-1

Maximum Speed	333RPM
Medium Speed	202RPM
Minimum Speed	116RPM

Three automatic feed rates taken are shown in table-2

Table-2

Maximum Feed Rate	50 mm/min
Medium Feed Rate	24.39mm/min
Minimum Feed Rate	12.37mm/min

On condition

Table-3

Diameter of work piece	20mm
Length of machining	8mm
Room Temperature	35 ℃

The temperatures are measured with the help of digital temperature display unit with Type K thermocouple wire and a sensor attached with it. The sensor senses the millivolt generated with the help of thermocouple wire and sends the signal to the temperature display unit which converts millivolt into temperature.

I have used three different types of cutting fluid which are-

- Urea based cutting fluid
- Motor oil based cutting fluid
- Coolant based cutting fluid

1. Experimentation with urea based cutting fluid

Table-4

Type of application of cutting fluid	Flood Mode
Quantity of cutting fluid	2 litre

Apply this cutting fluid based on selected configuration-

Table-5

Speed of lathe	Maximum
Feed rate	Maximum
Depth of cut	5mm
Temperature at the tool chip interface without cutting fluid	95℃
Temperature at the tool chip interface with cutting fluid	37℃
Temperature of chip without cutting fluid	160℃
Temperature of chip with cutting fluid	35℃
Temperature at tool tip without cutting fluid	150℃
Temperature at tool tip with cutting fluid	36℃
Temperature of work piece without cutting fluid	130℃

2. Application of motor oil based cutting fluid

Table-6

Type of application of cutting fluid	Flood Mode
Quantity of cutting fluid	2 litre

Apply this cutting fluid based on selected configuration-

Table-7

Speed of lathe	Maximum
Feed rate	Maximum
Depth of cut	5mm
Temperature at the tool chip interface without cutting fluid	95℃
Temperature at the tool chip interface with cutting fluid	48℃
Temperature of chip without cutting fluid	160℃
Temperature of chip with cutting fluid	36℃
Temperature at tool tip without cutting fluid	150℃
Temperature at tool tip with cutting fluid	39℃
Temperature of work piece with cutting fluid	35℃

3. Application of coolant based cutting fluid

Table-8

Type of application of cutting fluid	Flood Mode
Quantity of cutting fluid	2 litre

Apply this cutting fluid based on selected configuration-

Table-9

Speed of lathe	Maximum
Feed rate	Maximum
Depth of cut	5mm
Temperature at the tool chip interface without cutting fluid	95℃
Temperature at the tool chip interface with cutting fluid	53℃
Temperature of chip without cutting fluid	160℃
Temperature of chip with cutting fluid	51℃
Temperature at tool tip without cutting fluid	150℃
Temperature at tool tip with cutting fluid	48℃
Temperature of work piece with cutting fluid	49℃

CALCULATION OF TEMPERATURE REDUCTION BY DIFFERENT CUTTING FLUIDS-

Reduction in temperature by urea based cutting fluid at different location

1) Temp reduced at tool chip interface=95-37=58 degree
   %temp reduction=61.05%
2) Temp reduced at chip =160-35=125 degree
   %temp reduction=78.13%
3) Temp reduced at tool tip =150-36=114 degree
   %temp reduction=76.28
4) Temp reduced at work piece =130-30=100 degree
   %temp reduction=77.14%

Reduction in temperature by motor oil based cutting fluid at different location

1) Temp reduced at tool chip interface=95-48=47 degree
   %temp reduction=50.43%
2) Temp reduced at chip =160-36=124 degree
   %temp reduction=78%
3) Temp reduced at tool tip =150-39=111 degree
   %temp reduction=74%
4) Temp reduced at work piece =130-35=95 degree
   %temp reduction=73 %

Reduction in temperature by motor oil based cutting fluid at different location

1) Temp reduced at tool chip interface=95-53=42 degree
   %temp reduction=44.17%
2) Temp reduced at chip =160-51=109 degree
   %temp reduction=68%
3) Temp reduced at tool tip =150-48=102 degree
   %temp reduction=67.12%
4) Temp reduced at work piece =130-49=81 degree
   %temp reduction=62.30 %

CONCLUSIONS

The following conclusions could be drawn from the above investigation:

1) This paper provides us information about the effect of temperature using various cutting fluids like urea based cutting fluid , coolant based cutting fluid and motor oil based cutting fluid.
2) The maximum temperature reduction is obtained with urea based cutting fluid because formation of urea based cutting fluid in itself is an exothermic reaction and along with vegetable oil and shampoo
3) Urea based cutting fluid becomes a more effective cutting fluid. It is highly soluble in water, non-toxic and neither acidic nor alkaline.

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