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Influence of Cutting Fluids in Machining

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Abstract – *Cutting fluids are used during machining processes to increase the cutting properties at "tool work piece interface". While cutting, friction produced at the cutting zone tool chip interface results in more wear and tear affecting tool life, increase surface roughness of the work piece. Research reveals "that there is an improvement in the tool life and surface finish" from the use of water based solutions and organic cutting oils. In this paper effect of various coolants, oils and lubricants have been studied and it has observed that factors affecting surface roughness generally work piece material, types of chips, temperature at the cutting zone, kind of cutting process, various types of material used for cutting tool are taken into account along with "negative aspects of the cutting fluid on the health of workers i.e environmental hazards and the alternative ways out to reduce it". The study reveals that the combinations of machining parameters along with alternatives to the cutting fluids like dry machining, minimum quality lubricant and proper selection of various cutting tools help in reducing use of cutting fluids and minimizing adverse effects associated with it.*

Keywords*: - Cutting oil, surface finish, surface roughness, work piece material, cutting tool.*

1. INTRODUCTION

Cutting oils are basically used for minimizing the heat at the heat affecting zone, reducing surface roughness, improving tool life and transportation of metal chips. Cutting fluids mainly consist of polar based oils like vegetable oils, mineral oils and fatty oils. Synthetic fluids and semi synthetic fluids are not required fatty oils, vegetable oils and mineral oils but used emulsions and water but both types for the commonly used cutting fluids used in achieving the desired characteristics. The emulsion based cutting fluids in machining causing adverse effect both to the health of the employee and the environment to the greater extents. In addition to it "The cases of bad skin, breathing problems have been reported by the operators engaged due to the presence of chloro paraffins which are used as extreme pressure additives in the conventional cutting fluid"[1].Moreover "The effluents of the cutting fluids damages the soil and water resources as such cutting fluid must follow strictly the rules for the environmental protection". The common techniques employed to remove the above mentioned problem regarding environment is to perform the machining without using the cutting oils. Earlier practice is to avoid the cutting fluids by seeing its appearance and by seeing the rust on the machining parts. This practice results from fewer environmental regulation kept in place time to time [2].The study reveals that good facilities may represent overall saving of 15-50% by implementing a thorough right use of cutting fluids there by reducing overall cost saving. The common factors of rightly and wisely use of cutting fluids are as follows: -

- Selection of cutting fluids.
- Cutting fluid monitoring.
- Reuse of cutting fluid.
- Protection against bad effects of emulsion based fluids.

Cutting fluid monitoring and quality are very important elements of successful fluid management program [2]. Therefore fluid must be monitored to find out exact problem. In order to carry out successful fluid monitoring and maintenance it has been divided into periodic measuring the P.H value and regular checking. It is also important to note down the changes and its nature with specific time. The high market requirements on the quality and environmental management (Standards ISO 9000,ISO 14001,QS 9000) are in existence, the buyers show least interest in preventive inspection of fluids before being used[3]. F.W Taylor suggests that the cutting fluids helps in attaining high cutting speed and improved surface finish. [4].

2. LITERATURE REVIEW

The cutting fluids mainly employed in cutting zone interface or in a machining process originally has three characteristics [5, 6, 7] as follows

1. Cooling effect.

2. Effect of lubrication.

3. Removal of chips from cutting zone interface.

The important parameter ie cooling can be obtained by the effective use of cutting fluids.. It becomes an important factor to remove the heat from cutting tool chip and work piece interface. Effectively use of cutting fluids resulting in longer tool life due to less wear and tear of tool and there by improving the dimensional accuracy. It has been observed that stagnation of metal chips on the tools angles play a vital role and needs to be removed at once. The cutting fluids provides the ease to the chips to pass the rake angle due to less cutting

friction co-efficient due to lubrication. Moreover, in case of materials such as "Aluminum and its alloys" effect of lubricant reduces the formation of built up edges and thereby increases the smoothness of surface finish. [5,6,7]. It plays an important role in carrying away of metal chips from the cutting zone where the toll tip and metal surface interface. The result of transportation of chips and reduces the temperature at the cutting zone to some extent.[4,7].The use of cutting fluids in machining involves various parameters i.e kind of process used in machining, material of the job to be machined and types of composition that is being used for tools material. The process to be employed for cutting the material has a very co-relation with the cutting fluid to be employed to get the better surface finish. The result of machining process is also dependent on the job material and geometry of the cutting tool tip. Therefore decision of using cutting oils largely depends upon the process is employed for machining taking into consideration in use of less quantity cutting fluid to high quantity of cutting fluid are stated as under[5].

1. Surface Grinding
2. Planning
3. Cutting
4. Turning
5. Milling
6. Drilling
7. Shaping
8. Tapping
9. Threading
10. Boring
11. Profiling
12. Gear forming
13. Internal grinding
14. Gear hobbing

It reveals that the approach to use low quantity to high quantity of cutting fluids while cutting did not give good results. The composition of material and cutting tool geometry had not can make the difference up to some extent. [5].The deep machining processes like tapping, gear hobbing requires tools of special characteristics. In deep cutting such as tapping, gear hobbing highly densed cutting oils are used which have higher quantity of chemical components. Oils like natural oils and prepared oils have showed better performances in heavy cutting operation like tapping showed better results in comparison with the other water solutions in terms of surface finish in machining[5].It is recommended to use oil type cutting fluid rather than emulsions for better results[8].In threading operation cooling properties of cutting fluids are studied and lubrication by virtues of its properties are preferred over cutting oil due to cutting small amount of contact between the tool tip and job material. Moreover during drilling, keeping in view the profile of drill bit and shape of the unwanted material in the form of the chips, the spindle speed is normally kept low. It is is very important to take into consideration appropriate cutting fluid in case of drilling operation. In conventional drilling operation chlorine, additive mineral oils, emulsion oils are generally selected which not only reduces the heat generated but at the same time reduces the friction. The self lubricating drills bits have the role to play in the modern day drilling[8,9].Special purpose cutting fluids could be used as cutting fluids for finishing processes like honing etc. which shows good response while machining. The conventional processes like cutting, milling, shaping etc. and performing the operations with high degree of hardness tools it has been observed that appropriate cutting fluid would be water based as in these operations the contact area in the tool tip and job outer periphery is low. The cutting fluids having water has its major component dissipated the heat at the interfaces of the tool tip and job surface to greater extent and therefore minimizing the tools wear and tear [5,10].For grinding purpose the special purpose of cutting oils are prepared like emulsions and oils having increased density. The MRR in grinding in case of cutting fluids with high density give good results [5,10].The basic criteria for choosing the tools for machining is dependent on the nature of the job to be machined. In case of cast iron, the formation of dust particles like chips during machining and usages of water based cutting fluids resulting in the formation of debris at the cutting areas and thereby decreases the surface finish of the job. Therefore the emulsions based cutting fluids find good during machining of cast iron. To prevent the oxidation in case of water based cutting fluids during the machining, the percentage concentration should be kept around 12-15% [4,11]. Machining steel, the cutting fluids attaining high pressure and having mineral oils are used for early disposal of metal chips to stop the formation of built up edges at the cutting zone in order to reduce the surface roughness [8].

2.1 Cast iron

a. Cooling at the room temperature.

b. Cooling by forced air for early transportation of metal chips.

c. Use of emulsions in forming the balls at the tool tip and job surface interfacing for better surface finish.

2.2 Alloy steel

The machining of alloy steel mainly depends on the material of the tool and cutting fluids.

a. Use of HSS tool for machining mild steel, soluble cutting fluids are preferred.

b. if machining is performed by hard material cutting tool carbide and on medium carbon steel, the cutting fluids with low density is considered to be good.

c. For hard steel machining could be performed without any cutting fluids and can be machined by the use of air.

2.3Aluminum

Generally no cutting fluids are required to machine aluminum but in case of heavy cut the low density cutting oils could be used.

2.4 Copper

Cutting fluids with low density and having the properties of water soluble solutions could be used for machining the copper.

2.5 Straight steel

There is no use of cutting fluids while performing the machining on the material high hardness and brittle in nature for rough work but low density cutting fluids could be used for fine cutting. To get the high surface finish, neat oil is also used [14]. While cutting the hardest alloy steel material, there is considerable increase in the temperature at the cutting zone, therefore that cutting oil should be selected in such a manner that it must carry the cooling and lubrication properties. Moreover the important factor in machining titanium alloys is cooling factor as the high temperature is being developed at the cutting zone. Due to which, the induction of higher cutting speed also creeps in. In addition to it, the lubricating effect of selecting cutting fluid is generally taken into consideration, where the requirement of speed is least while machining. Cutting oils carrying the properties of the emulsions could be used in the conditions where machining is required on the materials hard in nature and very high cutting speed is required[11,15,16,17].For machining hard material and super hard material the type of the cutting tool to be used becomes very important and the cutting material could be chosen mainly on studying the tool applied and failures in the past. Selection of the cutting tools is an important criteria and the operator involves should have the knowledge of the following;

a. Can understand the drawing of the job.

b. Composition of job material.

c. Can handle machine tools properly.

d. Knowledge about the cutting fluids like its inert nature etc.

e. Formation of metal chips during the process.

f. Cutting tool geometry.

g. Surface finish of the desired product.

Selection of a cutting tool should carry the per-requisite properties:

a. Can withstand high temperature without loosing its properties.

b. Should have high degree of hardness than the job material.

c. Less wear and tear at the elevated temperature.

d. Retains its geometry during deep cutting.

e. Good response to the cutting oils.

When rates of metal removal increases, there is requirement of the tool material which can withstand the properties like high temperature, low wear and tear etc. HSS is preferred over carbon steels. In industries, high speed tools have edge over the carbide tools keeping in view the retaining of properties by the HSS in the extreme conditions.

3. CONCLUSION

Keeping in view the above study the cutting fluid and cooling effects resulted in benefits like improved surface quality, increased tool life, reduced tolerances of the work piece size, lesser amount of energy consumption, chip free cutting zone and good amount of tolerance against rust. The prime objective of feed rate, cutting speed and depth of cut could be achieved. The metal removal rates will be enhanced by taking into consideration the all the three parameters mentioned above. Another factor also reveals that the workers like machinist, turner etc. while working on the machines come in contact with water based cutting fluids and other cutting oils across the world. Tribology international 1983 revealed that they are more toxic than their components and may be allergic even if the raw material is safe [Bienkowski1993]. Due to the toxic nature of the cutting fluids the skin exposure is the major cause of concern to the workers results in the bad effect on their health. In connection to the above mentioned negative effects associated with the health of the workers alternative approaches for minimizing the effects of the cutting fluids while doing machining along with appropriate approach to the cutting fluids were studied and it was found that dry machining, quality of lubricant are the important parameters are detrimental in reducing the health issues of the workers. However techniques like cutting tools coating with the suitable materials could reduce the use of cutting fluids in the machining operations but still machining operations requires the use of various cutting oils in order to dissipates the heat and transportation of unwanted chips from the cutting zone. In view the above factors, the cutting fluids should be selected in such a manner that it gives maximum benefit with minimum negative effects. In addition to that other parameters like kind of tool material, various cutting processes and material of the job to be done would help in choosing the right cutting fluid oil to be used for particular machining operation for maximum results with less adverse affects on environment and also reduce the health hazards.

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