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REVIEW ON MACHINING TECHNIQUES: DRY MACHINING AND CRYOGENIC MACHINING

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ABSTRACT

As now a day, the demand of machining process is increasing as increased in manufacturing technology. Also with the increase in manufacturing process it is also concern to know about the machining techniques. as per machining techniques, tool failure is natural. To overcome this problem cutting fluid is introduced, due to this it is hazardous to environment. So according to this problem some of new machining techniques are consider like Dry machining and cryogenic machining. This is the investigation and research about the machining techniques used for turning and various operation in CNC and Lathe machines. This tools helps to obtain good surface finish. According to the law and legislation norms it is important factor to be consider while machining. Tool life is the way through which all the machining techniques are depend. By increasing the tool life, it will be beneficial in terms of productivity and machinability, also it saves the cost and mass production can be done easily.

Keywords: Dry machining, Cryogenic machining, Eco-friendly, Surface finish, Tool life .

I. INTRODUCTION

In machining operations the main by product is heat energy. Heat energy causes most undesirable effect on the Tool as well as work piece. The temperature produce while machining is determining factors for machined characteristic of work piece. Cryogenic cooling is used for the cooling and lubricating the work piece while machining. In olden days cryogenic machining was costly and was not widely in use. But now a days it is widely used in many industries for lubricating factor while machining. Cryogenic remove heat more efficiently from the cutting zone. In metal cutting process tool life is depends on the heat produce while machining. Advantage of cryogenic machines are it increases the processing speed with eco friendly by product. As cryogenic machining is not affordable many of the industries reliable on wet and near dry machining but do to this machining process it affects the environment cycle. So mostly preffered and less valuable machinable process is dry machining. In this the only difference is the use of coated tool and total avoiding of lubricant or any type of cutting fluid. But do to this process many times the tools get wear and get break at the tip of the tool so basically manufacturers use carbide coated or titanium coated tool is used for good surface finish and also irregularities are avoided during manufacturing. Advantage of dry machining are decrease cycle time, reduction in machine tool cost. This paper gives us the idea of selecting the machining process accordingly.

II. LITERATURE REVIEW

Machining of the metal components is required to use them as per the need so that machining is the basic component of manufacturing. In machining process errors may occur due to problems in machine tools and in different vibrating machine parts due to high temperature .These errors arise due to high cutting speed and more depth of cut. In turning operation ,cutting forces and surface finish is important aspects considered . By using uncoated tools without any coolant there will be high temperature generated and also tool damage can take place. So we need to avoid high temperature generation while machining.

III. CONCEPT

3.1 Dry Machining

Dry machining is considered a more sustainable process than machining with cutting fluid due to the absence of lubricants and coolants, which results in a reduced use of resources. In dry turning of titanium/super alloy, the cutting forces required are lower than those required using cutting fluids , and a better surface quality is achieved than in wet machining. There are many advantages of dry machining, such as increased flexibility, decreased cycle times, reductions in machine tool costs, and elimination of environmentally hazardous cutting fluids. To improve the fatique strength, corrosion resistance of the product surface roughness is desired. To enrich certain surface roughness in dry machining tools with carbide coated is necessary, also different types of coated tool is essential for cutting parameter. This type of tools influence the high temperature, high resistivity and also less tool wear. While turning operation in lathe or CNC machine hard coating deposits are necessary, it can be either done by PVD(Physical vapor deposition) and CVD(chemical vapour deposition).also some coating of PVD can be used at sharp edges and complex edges. Also this carbide coating tools play an vital role in tool life and machining performance.

Figure-1:-Turning operation by carbide coated tool.

3.2 Cryogenic Machining

Cryogenics is the phenomenon of production and effect at very low temp. It is originally from the Greek word 'Kryos' means 'Forst' and 'genic' means 'Production'. It normally includes the all the temperature below zero degree Celsius. But scientifically it is assume that start at −150 °C (123 K; −238 °F). The National Institute of

Standards and Technology has decided to consider the range of cryogenics as from temperatures below −180 °C or −292.00 °F or 93.15 K. Cryogenics mainly study in the Kelvin or Rankine temo scale.

3.2.1 History

The techniques of cryogenics is evolved during World War 2 when scientists realize that metals frozen to low temperatures become more resistive to wear. Based on this phenomenon of cryogenic hardening, Ed Busch founded the first commercial cryogenic processing industry in 1966.

3.2.2 Cryogenic Process

Cryogenic machining is a process of cooling the cutting tool and work piece during the machining process. This process is about delivering of cryogenic Fluid (instead of an oil-based Fluid) to the actual cutting zone of the tool ,which is in the region of the highest temperature during the machining , or to the work piece to change the material characteristics and improve machining performance. The cryogenic fluid used is nitrogen fluid. when nitrogen delivered to the cutting region as shown in fig., it immediately turn into vapor state and returns back to the atmosphere, leaving no residue to damage the part, machine tool, chips, or operator. Thus, it is eliminating disposal costs related to fluid usage. This makes it completely clean process unlike to conventional oil based fluid.

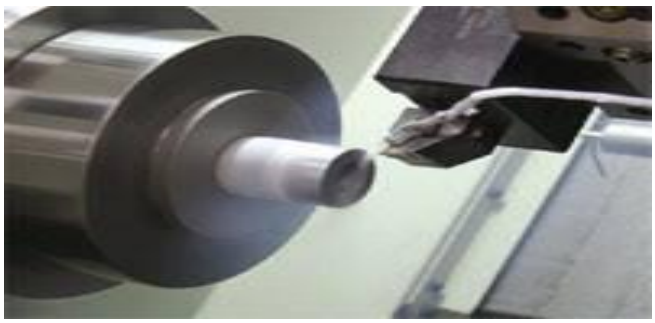

Figure-2:-Cryogenic machining operation

IV. CUTTING INSERTS

The tool is selected accordingly the work material and machining properties. To perform effective cutting ,the selection of proper cutting tool is very essential. According to work piece and manufacturing process carbide insert is used for cutting. As dry machining does not require lubricant ,the mainly used coated cutting tool is TiAlN, TiN, PCBN and other tools.

Table:-Properties

insert coated properties
▪ Lower friction
▪ Higher adhesion
▪ Higher resistance to wear and cracking
▪ Acting a a diffusion barrier
▪ Higher hot hardness and impact resistance

There are different types of inserts shape of different angles and shape

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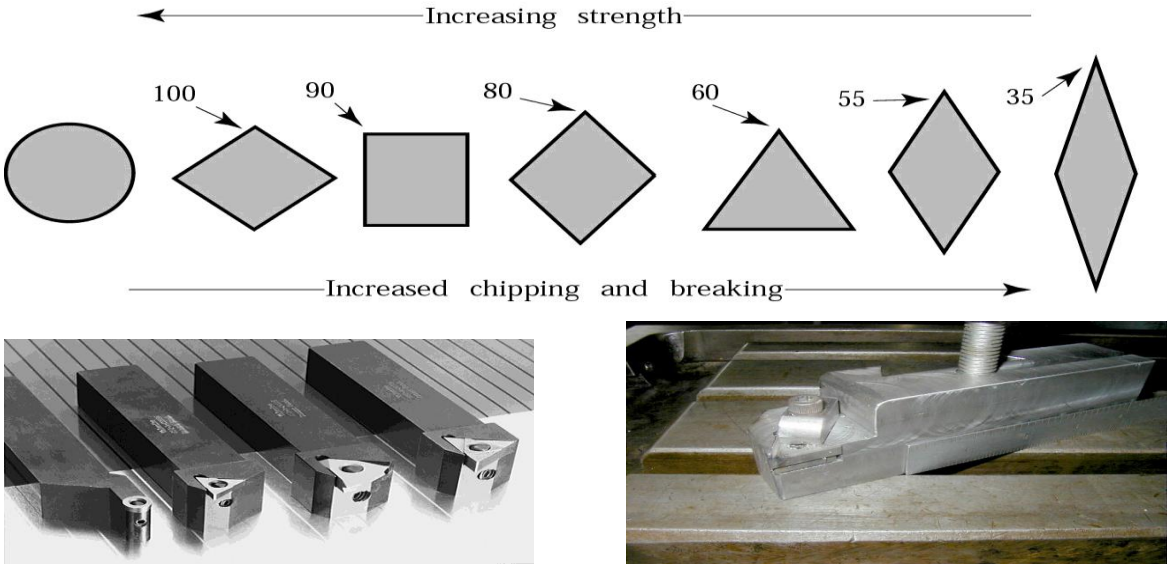

Figure-3:-Shapes of cutting inserts

V. CRYOGENIC PROCESS

In cryogenic machining the coolant is generally used is nitrogen. The figure of experimental setup is an in the fig .

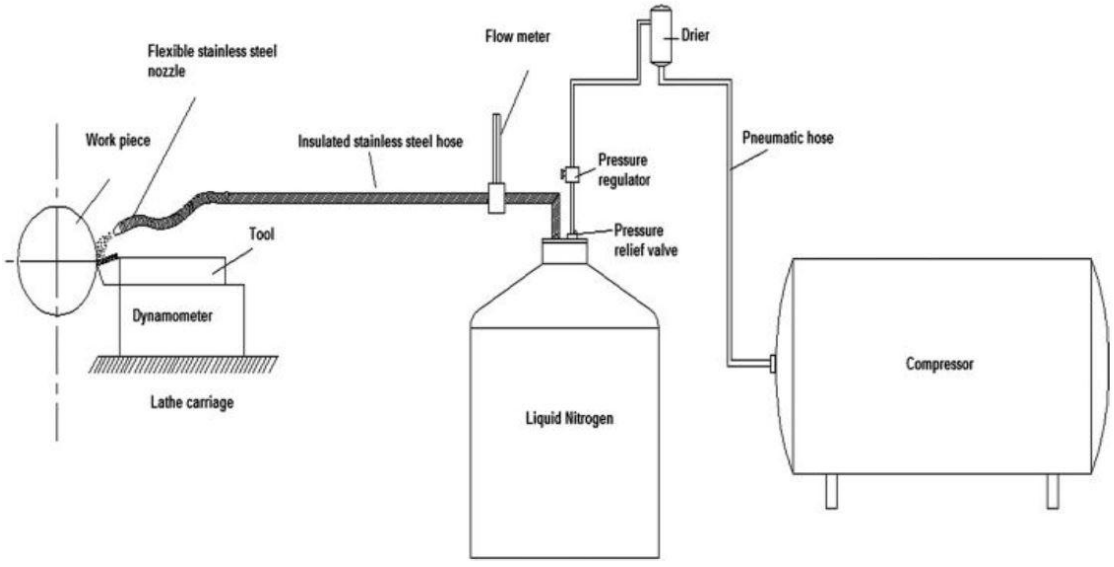

Figure 3:-Cryogenic setup

Here the fig shows the schematic setup of the cryogenic process the setup consist of the

1. Compressor
2. Liquid nitrogen storage
3. Drier
4. Flow meter
5. Flexible nozzle
6. Stainless steel hoses

By all the component the liquid nitrogen is spared directly in the cutting zone.

VI. WORKING

In both the type of processes the working is similar only the difference is the in cryogenic machining the coolant is used but in dry machining the coolant is not used. The Dry machining the special coated tools are used so that the ill effect do to machining can be minimized. The coated tools are bad conductor of heat so that at high temperature the distortion due to heat is less in coated tools rather than ordinary tools. So we can achieve more machining speed for good surface finish due to coating of the tool.

As in the cryogenic machining the coolant is used i.e. Liquid nitrogen is used. Due to the use of liquid nitrogen the heat is absorbed instantly so that the high temperature region is very less in case of the cryogenic machining. So the due to low temperature of coolant high speed can be achieved so the high surface finish can be achieved.

Figure-4:-Working of Dry machining and Cryogenic maching

VII. ADVANTAGES

7.1 Dry Machining

1. Increased flexibility.
2. Increase in productivity.
3. Decreased cycle times.
4. Reductions in machine tool costs.
5. Elimination of environmentally hazardous cutting fluids.
6. Non pollution of the atmosphere and Water.

7.2 Cryogenic Machining

1. Increase in cutting speed without increasing wear of tool.
2. Increase of productivity.
3. Increase in tool life.
4. Environmental friendly, cleaner and safer method.
5. Increase in product part quality.
6. Lower investment due to less no of machine tool.

VIII. LIMITATION

8.1 Dry Machining

1. causes high temperature.
2. High wear rate.
3. Shorter tool life.

8.2 Cryogenic Machining

1. Negative impact on economy, environment.
2. Consumption of costly coolant(liquid nitrogen).
3. Low temperature is Frost bite threat to operation.

IX. ANALYSIS

9.1 Dry Machining

Surface roughness is the main phenomenon in this type of machining techniques rather than using different machining process use of dry and cryogenic machining helps to recover the resources and also consider the available environment safety.

In any of based process there are two factors to be controlled

1. The process like speed feed ,temperature ,etc .by varying this parameter we can study the influence of surface roughness, accuracy, time and stability during the work piece manufacturing.
2. The most important factor is noise created during machining process, which is literally difficult to control and identify. This happens due to one or more process done at high cutting speed.

9.2 Cryogenic Machining

Cryogenic cooling is different approach and is beneficial in machining. Such as

1. Cryogenic machining is eco-friendly as the liquid nitrogen always evaporate into air
2. When gas other than liquid nitrogen is used(such as CO2) as the cutting fluid it helps to reduce cutting force and better chip brakeage is obtained.

X. CONCLUSION

We have presented overview of Dry Machining and Cryogenic Machining. This paper contributes the understanding of different tool shapes and tool insert used during machining. With proper understanding of cryogenic machining by using liquid nitrogen. Normally both the concept is eco-friendly, and good surface finish is obtained. This operation factor is associated with modern machining using cutting inserts.

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