ISSN (Online): 2348-0866
www.IJETI.com

Effect of Process Parameter on Machinability of Aluminium Alloy : A Review

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Abstract

This paper is focused on the effect of process parameter on the machinability of aluminium alloy. Machinability is the ability of being machined. We know many alloy of aluminium are possible and each alloy having different machinability and it depend upon many process parameter like cutting speed, feed, depth of cut, cutting fluid used, material of workpiece and tool, tool geometry, hardness of material etc. The review helps in selection of important process parameter for each type of alloy. For this we consider five to eight type of different alloy.

Keywords: Machinability of Al alloy, Process parameter, Microstructure process parameter, Properties of Al alloy

1. Introduction

Aluminium metal is easily available in earth crust and it is the third most abundant element present in the earth according to mass . Al alloy have many specific properties so it is used in industry.. The manufacturing process is the procedure for converting raw material or semi finished product into finished product. The aim of any industry is to manufacture a product economical such that the cost of production is low and productivity is high. When we change a semi finished product into finished product into finished then we perform following function i.e. change the physical properties of work, change size and shape of work, produced desired dimensional accuracy, surface finishing when we produced a product then machining operation are the base of the manufacturing industry.The machinability aspect is related to all phases of manufacturing, especially to process planning and machining operations. Machinability is a measure of ease with which a work material can satisfactorily be . The machinability aspect is of considerable importance for production engineers so that the processing can be planned in an efficient manner [1].Machinability are the important factor generally it can be defined as ability of being machined and more reasonable as ease of machining. Such as of machining character if any tool work pair is to be judge by tool wear or tool life, magnitude of cutting force, surface finish, magnitude of cutting temperature, chip formation[2].Any industry want to produce the product either at minimum cost or the product rate is high. Generally when produce a product then machinability is the important character and machinability depend on many factor such as material of tool and workpiece, tool geometry, machine capacity, cutting fluid, jig and fixture, clearance angle, nose radius,, microstructure, edge angle, rake angle when we produce a product then there are many difficulties are faced selection of material, operation performed, machine used, coolant used[3], so we use the different alloy of aluminium and steel each alloy have different properties and used for different purpose. For this we used different series of aluminium alloy each alloy have specific properties e.g. the strength of which alloy is high is used for making the aircraft, pressure cooker. The machinability can be measured by the machinability index. It is defined as the ratio of cutting speed for target material to cutting speed for the target material ensure tool life 60 minute. The value of machinability is always greater than 1.Many researcher used different alloy of aluminium alloy and steel for their purpose. They also used different tool geometry. So there are many different result were come into existence and find out output depend on many condition. That is some researcher used steel alloy they find out sulpher and lead improve machinability of steel. To manufacture a product is very lengthy process include from market survey to finished product. The process includes determining the requirement of the people, price of product, condition of product, market competition. When we study the industry engineering we saw that each day many factor change that is new technology is changes so it affect all the factor like parameter, demand etc. So machinability is important factor taken into consideration for product design. But it is not the top the priority in the process of selection of material.

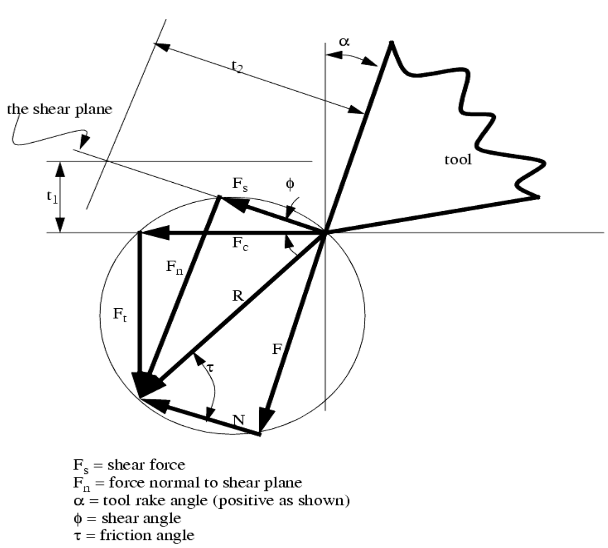
2. Working process and Principal

Machining is a process in which we remove the unwanted material and changed the raw material or semifinished product into finished product. The process of metal cutting in which chip is formed affected by a relative moment between the work and the hard edge of the cutting tool.

The relative motion is produced by a combine motion of rotary motion and translatory moments of either workpiece or tool or both.

Machine Tool	Relative Motion	
	Work Piece	**Tool**
Lathe	Rotatry	Translatory
Shaper, Planer	Translatory	Translatory
Drilling	Fixed	Rotatry & Translatory
Milling	Translatory	Rotatry
Surface Grinding	Translatory	Rotatry
Cylindrical Grinding	Rotatry & Translatory	Rotatry

After doing machining operation we calculate the all force by Merchant circle diagram. When we apply the force on the surface of workpiece then chip on aluminium surface is removed inform of discontinues chip. We know the chip is removed due to shear stress produced in the surface of work. For analysis process we draw the merchant circle and calculate the all force and stress produced in the work surface. The machine is done with the help of all machine like lathe ,drill, shaper etc. This result in removal of any access material interfering with the motion in the form of chip. Machining is done by both conventional and non conventional process. For better result we used the optimum process parameter. The merchant diagram represent the following force given.[4]



Chip thickness ratio (r) = $\dfrac{\textbf{uncut chip thickness (t)}}{\textbf{chip thickness (tc)}}$

$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha}$$

$$R = \frac{F}{\sin\tau} = \frac{N}{\cos\tau} = \frac{F_s}{\cos(\phi + \tau - \alpha)}$$

$$F_c = \frac{\tau_s\, A_o\, \mathrm{Cos}(\tau - \gamma_o)}{\mathrm{Sin}\,\phi\,\mathrm{Cos}(\phi + \tau - \gamma_o)}$$

$$F_s = F_c \times \frac{\cos(\theta + \tau - \alpha)}{\cos(\beta - \alpha)}$$

Where

$F_s = \text{Shear Force}$

$F_c = \text{Cutting Force}$

$\gamma_o = \text{Cutting Shear Strian}$

3. Literature Review

Dr. Genichi Taugh of Nipon (2003) perform an experiment which give varience for optitum setting of control parameter. Thus the result of experiment was given optimum value of process parameter. By this method he found out optitum setting of parameter design. The aim of this work is setting of parameter for machining of aluminium, SiC by using high speed steel tool. After some time Taughchi design of experiment was modified by kesavan eta al in 2004 .Because in the method of strain occurring durning the work. So the productivity of the machining is increased. Manna and Bhattchraya in 2004 used this method to define cutting parameter setting to achieve better surface finish during the operation of aluminium and SiC metal matrix (MMC) composite. We saw there are many modification is done in the Taguchi method to determine the Taguchi method to determine the optimum parameter tfor machining of aluminium alloy and steel. It id used at large scale in industry.[5]

Ali Mazahery and Mohsen Shabani (2011) performed a sliding wear test by taken various size and fraction of particle reinforced aluminium alloy by squeeze method. There were different microstructure of aluminium alloy produced. The structure of aluminium was homogeneous in nature. It was observed the wear and tear of the reinforced composite was higher as compared to unreinforced aluminium alloy. He also used the abrasive jet machining for penetration into the surface of reinforced aluminium alloy . They compared the surface of aluminium and its alloy. The surface of aluminium was very smooth as compared to aluminium.[6]

Benardos and vasniakos (2002) did a experiment on prediction of roughness of surface in machining on aluminium alloy surface. The published work divided into four major category. (1). Approached based on machining theory to develop model and computer algorithm that represent the machine suface.(2). Approach that describe the factor the factor affecting the results.(3). Approach based on used designed experiment (4). Artificial intelligent technics He compared the two technics on aluminium alloy and take artificial intelligence into consideration. The AI model is most accurate . Then they integrate it with computer and it is better conventional machining tecnics.[7]

Kuttolamadom et al.(2010) Performed a experiment on the fresh machined titanium surface. He formed an oxide layer on freshly machined titanium and instulate it against attack that provide it good resistance. Inspite of the limitation in in certain area aluminium still useful in food industry, cryogenic(Below 0 degree celusis) application and extensive in the transportation industry. Before it he had also reached on metal matrix composite element of TiC, TaC and to reinforce in alloy matrix, metal and iron or Al. unfortunately the study had lack of information. He found that aluminium MMC is an imp. Area of study but there are large limitation. They conducted in machining of LM6 is 84.96% of aluminium and 10-12% of silicon. The type of metal is impure due to alloy contain Al alloy known as Eutectic Al alloy and holding the lowest melting point.[8]

Edith Morinet al (1995) perform an experiment. He drilled a hole in 6061T-6 aluminium alloy and metal matrix composite sonsisit 22% of SiC. He measured torque, thrust, flank wear for different feed rate and different speed of drill. He find out a linear relationship between thrust and torque and wear at matrix . so he defined relationship between torque and wear at matrix material. Research on Al, SiC have focused on reinforce Al alloy. In 2006 peder and Ramulu modified it. They also perform on reinforce al alloy. The main purpose of these experiment to increase the surface roughness value and lies in the range of .2micrmeter to 3.0 micrometer. After there was large scope of the aluminium and its alloy inindustry and saw that two or more variables related each other. An experiment was performed there was the optimizing of parameter cutting force, torque, roughness. There are different parameter realated to each other called non linear mathematical mode. So we find out the process parameter for different variable machining and cutting speed.[9]

Cole G.S. and Sheranam A.M. (1995) mixed the cast iron and aluminium alloy for improving performance and efficiency. They find out alloy shows fatiques behavior due to its microstructure. For improving the wear performance a metal is reinforced with base alloy. For composite bonding is necessary between between aluminium and cast iron. Because due to presence of oxide of metal there is trouble between alloy and iron. The component was coated with a tin layer by electroplating and doing the heat treatment and produce the casting. They used gravity die and pressure die casting method. When the liquid state of Aluminium and cast iron mixed the bonding is formed in the liquid state. But there are difficulties due to the light alloy and high service temperature. The body made of aluminium and alloy made a thickness 20 to 50 times the pore diameter and completely filled with the piston. It is used for load bearing regeion to improve the performance[10].

Durrant G. et al (1996) explained about the aluminum alloy reinforced with mild steel insert by squeeze cast technique. The bonding of aluminum silicon alloy with the reinforced insert plays a vital role in improving the service life of the component.[11] The importance on the suitable registry between these reinforced insert and alloy is restricted by the surface contaminants and surface oxides[12]. The aluminum alloy casting having a porous metal insert improves the bonding strength by squeeze casing technique.

So the formation of any alloys is an evolutionary process not a radical process that is why aluminum alloys have no exception of this. There are many aluminum applications which are undergoing a reduction in weight and strength and hardiness of aluminum is improved by making alloys. Research in many field of aluminum engineering, such as advanced alloys, rapid solidification, composites and corrosion resistance, is aimed at keeping aluminum competitive in traditional as well as in many new applications [13]. Aluminum alloys such as Al-Si, Al-Cu-Si and Al-Mg-Zn alloys are widely used in aerospace bodies and other engineering industries due to their light weight and high strength to weight ratio. The use of conventionally processed Al alloys is sometimes limited by their low strength at temperature above 220^{0}C. Above this temperature the mechanical properties deteriorate with temperature. Aluminium- transition metal Systems have the potential for high temperature applications. Among the Al-TM system, Al-Fe-V-Si, Systems have altered considerable interest due to its high strength at room as well as at elevated temperature. Iron is always present in Al alloys. The solid solubility of iron in Al is very low (< 0.03 wt. %) .Therefore most of the iron appears as large intermetallic phases in combination with Al and other elements. Iron reduces the grain size in wrought product [14]. Iron increases the hardness and decreases the ductility. Iron increases corrosion resistance, creep strength and also improves somewhat the machinability of Al. Al-Si alloys have the potential for excellent cast ability, good weldability, good thermal conductivity, high strength at high temperature and good corrosion resistance. There are, therefore, many application aeronautic design of aeroplane, structural applications of vehicle in automobile industries, military applications etc. Fine Grain refinement of the casting yields several benefits. A fine grain size results in mechanical properties that are uniform throughout the material. Also, as the grain size decrease, the distribution of secondary phases and porosity is on a finer scale, and Machinability is improved [15]. Therefore V is added to these alloys for its grain refining effects.

4. Conclusions

1. Machinability of Al alloy is increase
2. Machinability index is increased upto 1.5
3.Optimum process parameter is determine for each type of alloy
4. Hardness of Al alloy increase from 3 to 4%
5. Uniform tensile strength is imcrease.
6. Cutting Force required is more when we increase speed, feed, depth of cut
7. Casting affects the machinability of aluminium
8. The mechanical properties of the Al alloy is improved by heat treatment and the chip is removed in form of discontinues chip.

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