STUDY ON OPTIMIZATION OF PROCESS PARAMETERS OF ALUMINIUM ALLOY

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Abstract: ***This paper is focus on the "To analyze the process parameter of aluminium alloy and determine the optimum value of process parameter." We know various series of alloy are possible i.e. 1xxx,…..8xxx,9xxx. Every series of aluminium has different properties, it depend on the process parameter like speed, feed, depth of cut, tool geometry, hardness of material etc. This paper helps to determine the process parameter for each type of alloy. For this purpose we use different alloy for machining and determine the process parameter for each alloy.***

Keywords*:* ***Process Parameter of aluminium alloy like speed, feed, depth of cut, Microstructure process parameter, properties of aluminium alloy, Tool geometry.***

1. INTRODUCTION

Aluminium metal is easily available in earth crust in form of ore and it is the third most abundant element present in the earth according to mass. It is used at a high level in the industry today. It is very versatile and can be used on so many different levels for different uses and purposes. It was discovered by Hans Christian Oersted in1825. The atomic number of aluminium is 13. Some important physical properties of Al are melting point of Al is 660.4 degree celcusis, non-magnetic in nature, easily malleable. Some chemical properties include it form aluminium oxide when come in contact with oxygen, highly flammable.[1-4] We know every industry wants to -manufacture a product economically so the production cost is low and productivity is high. When we manufacture a product then we mind the following function i.e. physical and chemical properties of workpiece, size and shape of product, dimensional accuracy, surface finishing. Generally when we make a product then there are number of steps involved such as design of product, process planning, machining operation and qualify control. For each there is a different department in an industry and large number of process parameters involved in each step.[5-7] The machinability is an important parameter because all other process parameters like tool geometry, feed, speed, are related to it. Machinability is defined as 'ability of being machined' or we can say 'ease of machining'. Such ease of machining is judged by tool wear, tool life, cutting force required, surface finishing, formation of chip etc. Machinability can be measured in term of machinability index which is the ratio of cutting speed of metal for one minute tool life to the cutting speed of standard free cutting steel for one minute tool life. So we can say we can improve the machinability by using different process parameter economically

Machinability index=v_t/v_s

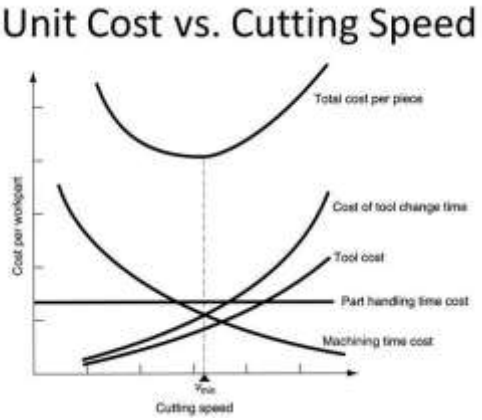
V_t=cutting speed of metal for one minute tool life

V_s=Cutting speed of standard free cutting steel for one minute tool life

The selection of variable is a big problem for an industry. It depends on the Techno-economic needs of a process. In overall performance it is necessary to develop a scientific/mathematical tool for determining the optimum value of process parameter. Based on the work we perform following operation.

1) Process for changing of physical properties of material like annealing, hardening, tempering, surface hardening.
2) Casting process: Die casting, Centrifugal casting, Sand casting.
3) Joining process: Welding, Soldering, Milling etc.
4) Machining process: Turning, Drilling,
5) Shearing and forming process: punching, banking , drawing .
6) Primary metal working process : rolling ,forging, extrusion, wire drawing
7) Surface finishing process: Lapping honing , super finishing.

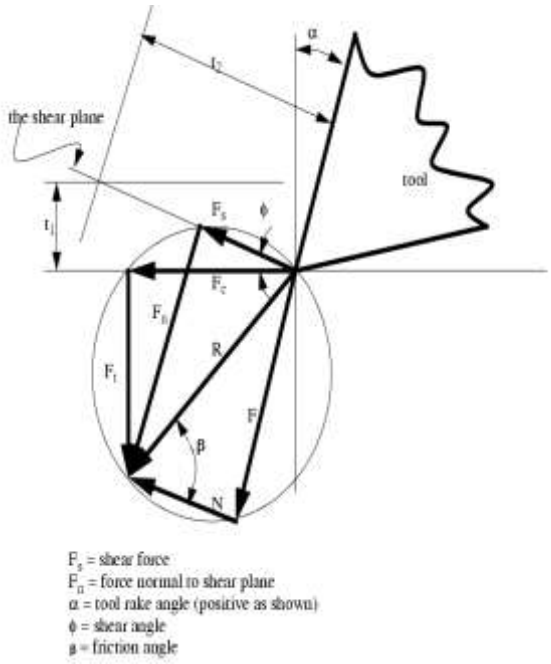
So we choose the optimum speed to optimize tool life ,maximize production rate. Because there are many factors so consider any two factor constant and determine the optimum value of any factor by contour graph drawing. The following graph gives the economics of metal cutting when the cost of tool is minimum the tool life is more.



2. WORKING PROCESS AND PRINCIPAL

Machining is a process in which we remove the unwanted material in the form of small chips and this raw material into final product. The chip is removed by a relative moment between the work and hard edge of the cutting tool. The relative motion is produce by a combine motion of rotary motion and translatory moment of either workpiece or tool or both. A machine tool is a non-portable power operated which produces the ebergy used to produce job. The machine tool may be powered by hydraulically, electrically or any other way. When metal is removed in the form of chip we saw the chip is in equilibrium. The force on the chip and tool face and this force is resultant of normal and tangential component of force on tool face. If we saw R' it is the force between the chip and workpiece and it is the resultant of normal and tangential components on shear plane, The merchant circle gives the representation of all forces on a plane surface which are convenient

to calculate the relationship between different forces and angle . In Merchant diagram two force triangles are formed which gives resultant in form of a single force. The force R can be resolved in two component F_c and F_t. The numerical value resolved in two component of F_c and F_t can be determined with the help of Dynamometer.



F_s = shear force
F_n = force normal to shear plane
α = tool rake angle (positive as shown)
ϕ = shear angle
β = friction angle

$$F = F_C \sin\alpha + F_t \cos\alpha$$

$$N = F_C \cos\alpha - F_t \sin\alpha$$

$$F_S = F_C \cos\phi - F_t \sin\phi$$

$$F_N = F_C \sin\phi + F_t \cos\phi$$

$$F_N = F_S \tan(\phi + \beta - \alpha)$$

$R=F_c+F_t$

The rake angle (□) can be measured from the tool directly. Forces F and N can then be determined by using force relationship. The shear angle(□) can also be measured and by using force relationship we measure F_s and F_n. The working process include:

- Preparation of alloy
- Pouring of metal
- Procedure of machining
- Study of process parameter for optimum value

3. LITERATURE REVIEW

The development of any alloys makes a change because we get many combined properties related to different elements in a single element or alloy. Today for many applications we required a reduction in weight as strength and durability of element and it is possible in alloy. For this purpose we developed aluminium alloy. Research in many areas of aluminum technology, such as advanced alloys, rapid solidification, composites and corrosion resistance, is aimed at keeping aluminum competitive in traditional as well as new applications [8]. Aluminum alloys such as Al-Si, Al-Cu-Si and Al-Mg-Zn alloys are widely used in aerospace, ships and other engineering industries applications due to their light weight and high strength to weight ratio. The use of conventionally produced Al alloys is limited because of their low strength at temperature above 210^0C .Beyond this temperature, the mechanical properties decline with temperature. Al-TM (TM - transition metal) Systems have the potential for high temperature applications. Among the Al-TM system, Al-Fe-V-Si, Systems have tainted 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 (< 0.04 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 [9]. Iron increases the hardness and decreases the ductility. Iron increases corrosion resistance, creep strength and also improves somewhat the machinability of Al. We know each element has specific property for purpose we make an alloy. Al-Si alloys have the potential for excellent cast ability, good weld ability, good thermal conductivity, high strength at high temperature and good corrosion resistance. There are, therefore, well suited for aerospace structural applications, automobile industries, military application etc. By Grain refining of the casting we improve many properties. If we get grain size is fine then all mechanical properties are uniform throughout the material. Also as the grain size decrease, the distribution of derived phases and porosity is on a better-quality scale, and Machinability is improved [10]. Therefore Vanadium is added to these alloys for its grain refining effects.

4. RESULT AND ANALYSIS

For determining the optimum value of process parameter contour plots were used. These are plotted for each value of two influential processes parameter while other parameters remain constant. A contour plot is usually display the region of optimal factor setting. Once the stationary point is found the parameters value can be determined. The role of Contour plots is very important role for studying of response surface[11].For this purpose we use the Trial version of design expert software. This will give the optimize value of the process parameter for obtaining the maximum responses.

- Hardness is increases asll iron contents increases fromll 4 to 5 %
- As iron % increases, UTS sharply increases but %l elongation decreases.
- The mechanical properties of the alloys are improvedl through hot rolling of the cast samples by 80% reduction gives the best ultimate tensilelstrength.
- Hardness islalmostlconstantll atl 250˚C up toll 240 hours.
- From the experiments itll hasll beenll seen that thesel alloys is having good machinability.
- As Depthll ofl cutl andll Feedl ratell increases, cutting force is requiredll more
- Machinability inex of aluminium alloy lies between 300 to 1500.

REFERENCE

[1] Mills, B. and A.H. Redford, Machinability of Engineering Materials, Applied Science Publishers, London/New York 1987.

[2] Boothroyd, G., Fundamentals of Machining and Machine Tools, Scripta Book Co., Washington, DC, 1975.

[3] Taylor, F.W., "On the art of cutting metals", Trans.ASME, 28, 31(1906).

[4] M.F. Ashby, Y.J.M. Brechet, D.Cebon,L.Salvo," Selection strategies for materials and processes" Material and Design 25 (2004) 51-67.

[5] H. Lianxi, Y. Yiwen, L. Shoujing and X. Xinying, "Investigation on the kinetics of infiltrationll of liquid aluminium intol an aluminall fibrous preform", J. Mats. Process. Technol., vol.94, No.2-3,ll pp.227-230, 2012.

[6] K. Asano and T. Noguchi, "Trend of Composite Casting Technology and Joining Technology for Castl Iron", J.JFS, vol. 78, No.3, pp.96-105 ,2016.

[7] T. Sagall andll S. Ikeda, "Turningll machinability of Al2O3 -SiO2"shortfiber reinforcedll ADC12 aluminum alloy composites", J.JILM, vol. 41, No.4, pp.264-269, 2017.

8. Edward J. Kubel Jr.: Aluminum alloys: A Push for Excellence, Advanced Materials and Processes inc. Metal Progress, 1986, vol.12, pp 43-49.

9. L.M. Mondolfo, Aluminum Alloys- Structure and Properties, Butterworths, London, 1976.

10. A.K. Srivastava, S.N.Ojha, and S.Ranganathan: Microstructural Features and Heat Flow Analysis of Automized and Spray-Formed Al-Fe-V-Si Alloys, Metallurgical and materials Transactions A, August 1998, vol 29 A, pp 2205-2219.

11.https://www.sciencedirect.com/science/article/pii/S2214914715000203