Experimental investigation of optimization of machining of AL6065-TiC composites using TAGUCHI technique

I.Justin antony Raj[1], Dr.D.Lenin singaravelu[2], A.Padma gangeshwari[3], R.Ram kumar[4]

[1 3 4] *Assistant Professor, Department of Mechanical Engineering, VANDAYAR ENGINEERING COLLEGE, pulavar natham ,Thanjavur-613501,TN- India*
[2] *Assistant Professor, Department of production Engineering ,NIT-Trichy,TN-India.*

Abstract: *Applications of this project is for the manufacture of wear resistant tools, cutting tools, coating for abrasive steel bearings, wear resistant tools, optics applications, enhance the conductivity of materials and as a nucleating agent. Primary objective of machining operation is to improve the surface finish during the machining of AA6065-Tic composite. Poor surface finish is obtained because of presence of hard Tic particles and also the contact between tool materials on the contact surface of the workpiece. Recent mathematical and computational advances have fashioned a number of researches focusing on several aspects of modeling and analysis of surface finish .Many literatures indicate that , some parameters which affect the surface finish during turning process . surface finish parameters during machining of Al6065-Tic composite is verified .With this overall view, the present work is about to study the surface finish with different parameters.L9 orthogonal array is selected to conduct the experiments .*

Keywords: ***Turning ,Al-Tic composite, Taguchi method, machinability.***

1.INTRODUCTION

Al-Tic composites are studied through by literature survey .The effect of machining parameters on maching of Al6065-10%TiC composites are studied .The effect of turning parameters are studied .ANOVA tool is used for analyzing and verifying the practical works. Probability plots are studied for residuals(errors)

2.LITERATURE SURVEY:

Jianxin Deng. et al (2007):Above researcher conduct experiments on Al_2o_3-TiC ceramic composites with the additions of CaF2 and the ceramic composites exhibited self lubricating. R.Landfried .et al: Above researcher conduct experiments on processing of extrusion requires mold materials with high wear resistance ,high quality of the manufactured products and high performance ,toughness.S.Gopalakannan et al.(2011): Above researcher conduct experiments on newly fabricated metal matrix nano-composite was prepared by a novel ultrasonic cavitation method.Finally EWR and SR using desirability function approach.Belete sirahbizu yigezu. et al(2013):Above researcher conduct the experiments on situ synthesized of full factorial design.Multi response and control factors. Research Gap:Above researcher is not done with surface finish was identified as 1000rpm speed , ANOVA analysis,the significant parameters were identified as speed and feed with higher percentage contribution and is not done level combination for minimum surface finish was identified as 1000rpm speed ,0.05 mm/min feed and 0.5 mm depth of cut and not researched over the significant parameters were identified as speed and feed with higher percentage contribution

3.EXPERIMENTAL DETAILS

3.1 CNC lathe settings

Fig.1.Flat bed CNC lathe CK-6130

Machine Features:

- Max.swing over bed 300mm
- Max. processing Length 290 mm chuck / 400 mm collet
- Spindle speed of 150 - 2500 rpm for fast machining for large jobs
- Machine available with 4 station Gang type tool post

- Machine Dimension 1750*1200*15700 mm
- X/Z axis Torque 4/4 N.m
- X/Z axis Fast Feeding speed 8/10 m/min
- spring Chuck and Hydraulic chuck both are available

3.2 PREPARATION OF COMPOSITES SETTINGS:

Al 6065 Alloy powder was melted in the furnace and after reaching to the molten stage the TiC reinforcements are added on the weight basis to the molten matrix to produce the composite .

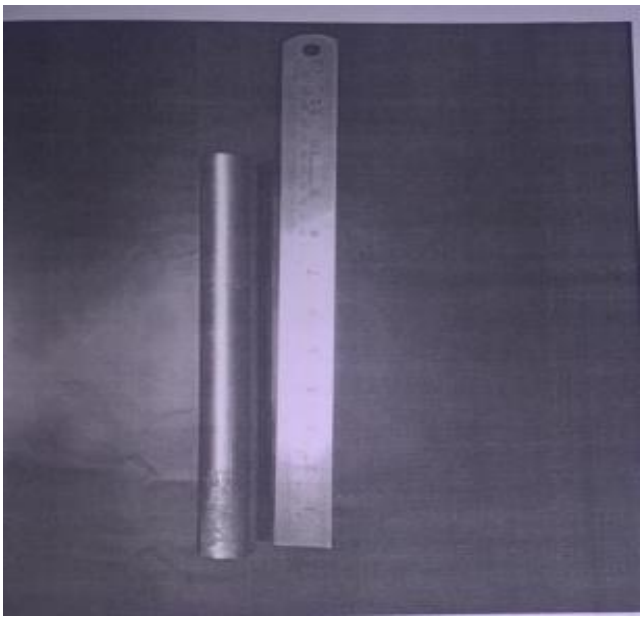

Fig.2.Photograph for composite sample AL6065 TiC

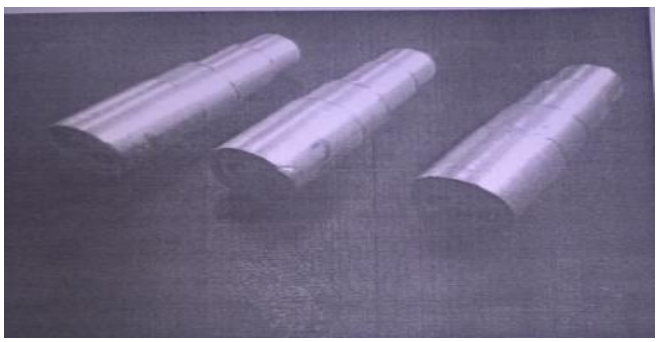

Fig.3.Photograph for composite machined

Table-1. Materials:

Matrix Material	Al 6065
Reinforcement	TiC
composite	Al 6065+10%TiC
Processing Route	Stir casting

Table-2. composition of Aluminium Alloy 6065 (Matrix)Used for the project:

S.NO	Aluminium Alloy	composition
1	Aluminum,Al	94.4-98.15%
2	Bismuth,Bi	0.50-1.5%
3	Chromium,Cr	<=0.15%
4	Copper,Cu	0.15-0.40%
5	Iron,Fe	<=0.70%
6	Lead,Pb	<=0.05%
7	Magnesium,Mg	0.80-1.2%
8	Manganese,Mn	<=0.15%
9	Other,each	<=0.05%
10	Other,total	<=0.15%
11	Silicon,Si	0.40-0.80%
12	Titanium,Ti	<=0.10%
13	Zinc,Zn	<=0.25%
14	Zirconium,Zr	<=0.15%

TITANIUM CARBIDE (TiC)

TiC is used on its own for enhance the strength of maching tools .Because of its refractoryness is used in machining .

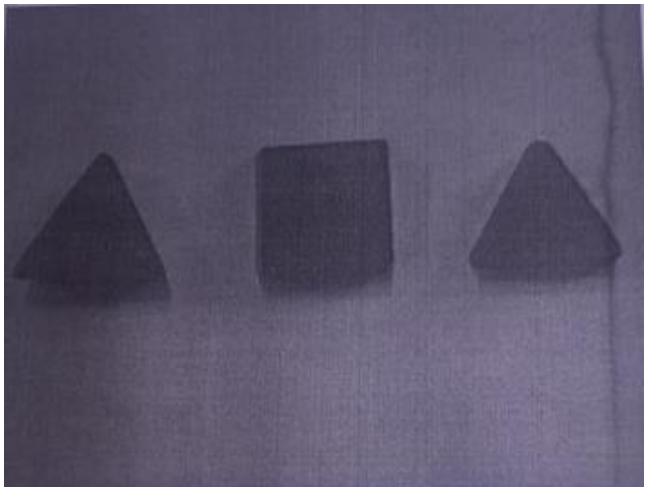

Fig.4.Photograph for Tool (Tungsten carbide)

Table-3.properties of TiC

S.NO	Property	Value
1	Density	4900kg/m
2	Electrical resitivity	0.003-0.008Ω*m
3	Hardness,knoop(KH)	2470 kg/mm.

4. Methodology

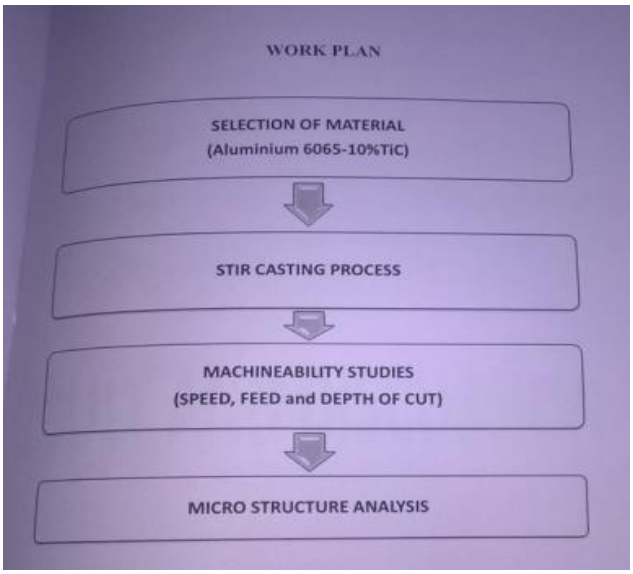

Fig.5.Flow chart for work plan

Work plan consists of selection of Aluminium 6065-10%TiC material and it will under stir casting process. Machinability parameters to studied like speed ,feed, depth of cut. Metallurgical micro structure analysis to be studied .

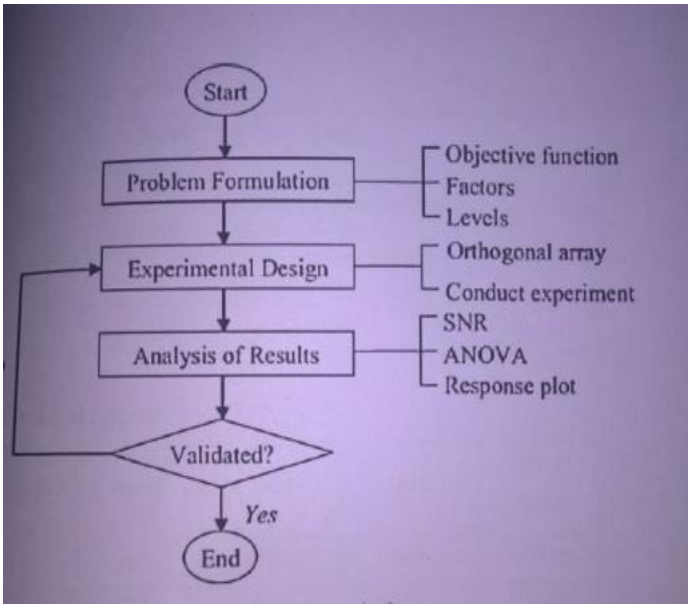

Fig.6.Taguchi's method

The Taguchi arrays are designed by manually ; arrays can be found online. The arrays are selected by the states. This is further explained later in this article. Analysis of experiments can be used to select new parameter values through performing chi-squared test to test significance.

5.Result and discussion

Table.4. shows the three levels of speed ,feed ,depth of cut for Taguchi design. Three factors are used for study the effects on the output.

Table-4. Range of parameters

Level	speed	feed	DOC
	rpm	mm/rev	mm
01	500	0.05	0.5
02	1000	0.1	0.75
03	1500	0.15	1.0

We have considered L9 orthogonal array to conduct experiment for getting more acceptance details of the said process

Table-5. Details of parameters

Experiment Number	speed	Feed	DOC	Surface Finish
	rpm	mm/rev	mm	micron
01	500	0.05	0.5	0.8340
02	500	0.1	0.75	0.9710
03	500	0.15	1.0	0.9950
04	1000	0.05	0.75	0.6210
05	1000	0.1	1.0	0.8430
06	1000	0.15	0.5	1.0750
07	1500	0.05	0.75	1.0245
08	1500	0.1	1.0	1.9560
09	1500	0.15	0.5	1.1870

L9 (3*4) Array.

Table -6. Response Table for signal to Noise Ratios, smaller better

Level	speed	Feed	DOC
1	0.6253	1.8349	-0.1802
2	1.6645	-1.3628	1.3945
3	-2.5089	-0.6912	-1.4335
Delta	4.1734	3.1976	2.8280
Rank	1	2	3

Speed is getting first rank in response table for signal to noise ratios smaller is better for influencing the output parameters which involving reduction of surface roughness.

Table -7. Response Table for Means

Level	speed	Feed	DOC
1	0.9333	0.8265	1.0320
2	0.8463	1.2567	0.8722
3	1.3892	1.0857	1.2647
Delta	0.5428	0.4302	0.3925
Rank	1	2	3

TAGUCHI ANALYSIS:

In the present work ,surface finish is taken as the objective and Taguchi chosen to minimize the objective function (i.e roughness value)

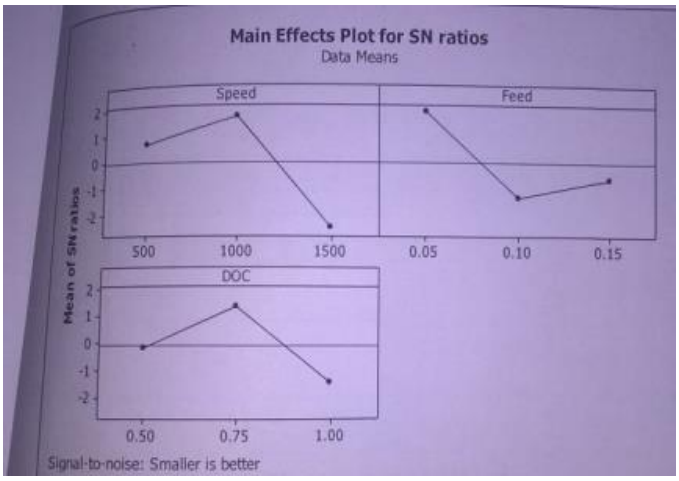

Fig.7.Main effects plot for SN ratios (Units:speed in Rpm,Feed in mm/rev, DOC in mm)

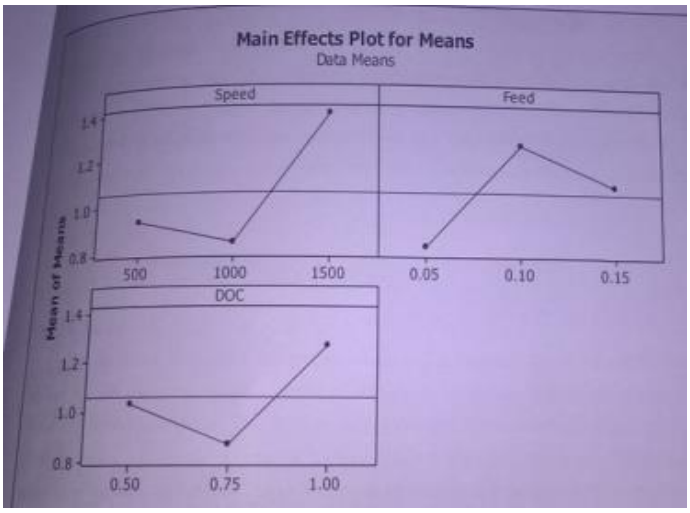

Fig. 8.Main effects plot for means (Units: Speed in RPM ,Feed in mm/rev, DOC in mm)

From the main effect plot as shown in Fig.8, it is observed that in order to get minimum surface finish,the optimal process parameters should be in middle level for speed ,low level for feed and middle for depth of cut .Further it is also observed from the main effect plot that speed has the strongest influence on surface finish followed by feed and depth of cut .The speed ,being the predominating factor on surface finish, when increased from 1000rpm to 1500 rpm, for all the feed and depth of cut.

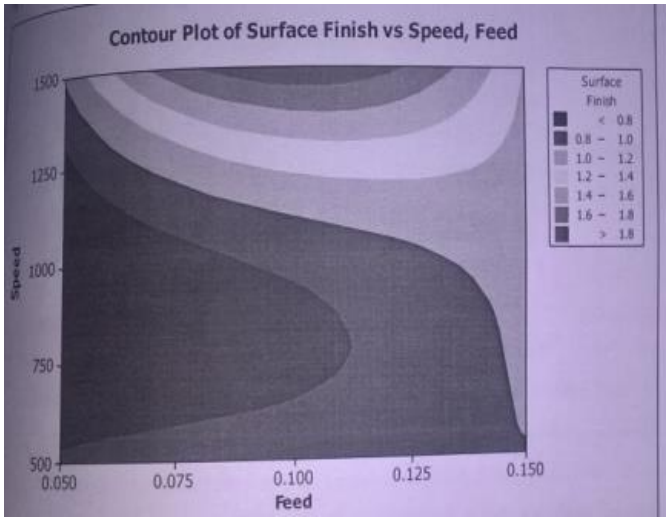

Fig.9.Contour plot of surface finish versus speed, feed.

From contours shown in fig.9, it is observed that for the materials tested the surface finish is less when the speed is lower than 1000rpm

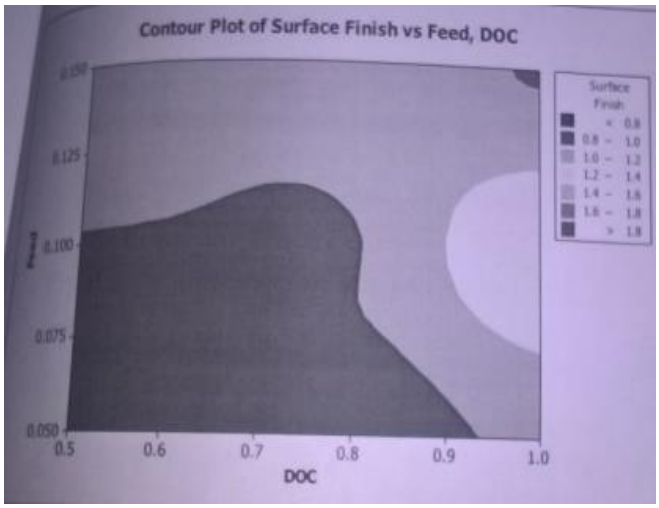

Fig.10.Contour plot of surface finish versus feed, doc

When the load is above 1000 rpm, an exceptional surface finish of less is observed only for AA6065-10wt%TiC composite which shows that the AA6065-10wt%TiC composite is having better surface finish than the other alloy and composite at higher speed .When the feed is average ,a better surface finish is observed irrespective of the speed as shown in Fig.10

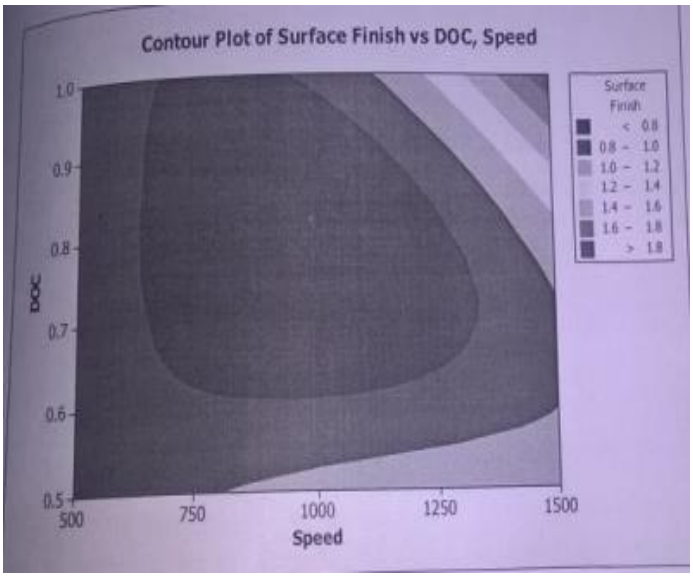

Fig.11.Contour plot of surface finish versus DOC, speed.

Table-8. Analysis of variance for surface Finish , using Adjusted SS for Tests

Source DF	Seq SS	Adj SS	AdjMS	F	P
Speed 2	0.5100	0.5100	0.2550	1.92	0.342
Feed 2	0.2815	0.1145	0.0573	0.43	0.698
DOC 2	0.0668	0.0668	0.0334	0.25	0.799
Error 2	0.2651	0.2651	0.1325		
Total 8	1.1233				

S=0.364047 R-sq=76.40% R-sq(adj)=5.62

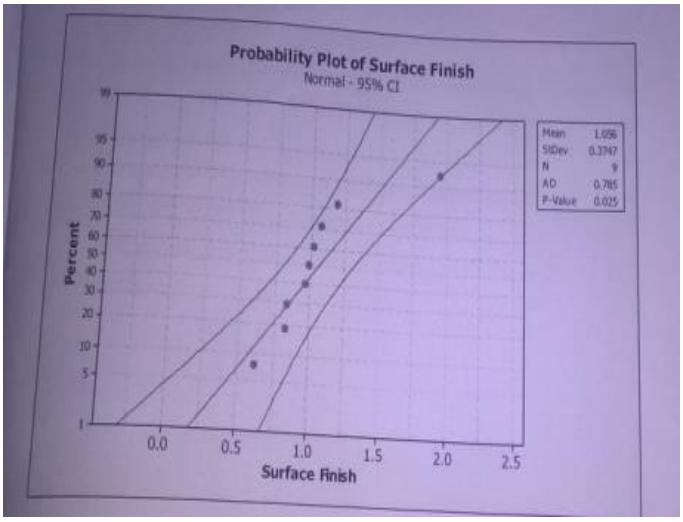

Fig.12.Probability plot for surface finish

The residuals (errors)are found to be normally distributed along the straight line.

6. Conclusion

Effect of machining parameters on machining of Al6065-10%TiC are studied and conclusions are derived.

Detailed literature survey has been carried out on processing and maching of Al-TiC composites.

Al6065 -10%TiC composite have been synthesized through stir casting route.

From the main effect plot ,the optimal level combination for minimum surface finish was identified as 1000rpm speed ,0.05 mm/min feed and 0.5 mm depth of cut.

From the ANOVA analysis,the significant parameters were identified as speed and feed with higher percentage contribution .

The residuals (errors) in the normal probability plot are found.

REFERENCES

[1] BeleteSirahbizu Yigezu, "modelling the abrasive wear characteristics of in SituAl-12%Si/TiC composites" Vol. 50, Sept. 2013, pp. 277-284. Materials and Design ,

[2]VelusamySenthilkumar, "Effect of Titanium carbide particle addition in the aluminium composite on EDM process parameters", vol. 13 ,Issue No: 1, January 2011, pages 60-66,Journal of Manufacturing processes.

[3] V.Janakiraman,"Concurrent optimization of machining process parameters and tolerance allocation ",vol.51, Issue No:1,24 march 2010, pp 357-369,The international journal of Advanced manufacturing Technology.

[4]Paras kumar ,"Experimental investigation and optimization of EDM process parameters for machining of aluminium boron carbide (Al-B4C)composite ",vol.20,June 2016,Issue No:2,pp.330-348.Machining science & Technology.

[5]Ravinder kataria,"Experimental investigation and optimization of machining characteristics in ultrasonic machining of WC-Co composite using GRA method",vol.31,2016,Issue No:5,pp.685-693.Materials & manufacturing processes.

[6]T.Rajmohan,"Experimental investigation and optimization of machining parameters in drilling of fly ash filled carbon fiber reinforced composites",Jul.2016,pp.1-10.Particulate science and technology.

[7]Upinder kumar yadav,"Experimental investigation and optimization of machining parameters for surface roughness

in CNC turning by Taguchi method",vol.2,Issue No:4,Aug.2012,pp.2060-2065,International journal of engineering research and applications(IJERA).

[8]B.Rajesh kumar lodhi,"Optimization of machining parameters in EDM of CFRP composite using Taguchi technique",vol.5,Issue No:10,Oct.2014,pp.70-77,PP.70-77.International Journal of mechanical engineering and technology(IJMET).

[9]Ravinder kataria ,"Experimental invstigation into the hole quality in ultrasonic machining of WC-Co composite ",vol.30,Issue No:07,July.2015,pp.921-933.Materials and manufacturing processes.

[10]Ravinder kataria ,"Ultrasonic machining of CNC-Co composite material :Experimental investigation & optimization using statistical techniques ",feb.2016.Research article.