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Experimental Investigation Of Friction Drilling On Al6061-T6 Aluminum Alloy

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Abstract:

In addition of normal drilling Form drilling increase a strength of bolts this is of joining of different types of materials. This chip less hole making process that may utilize the friction which is generated by rotating tool to infiltrateon work material and creates the drill by forming the bushing without creating the chip. With the help of this contemporary hi-tech technologies we also can reduce the machining time, improves the quality of joints, environment will also be not effected and less expensive. This research investigate that effects of rotational speed on bush formation, tool wear, androughness of hole surface in friction drilling of Al6061-T6. The experimentsare conducted on Universal Radial Drilling Machine SMT-R-2/12/97 with different speeds, and feeds of 495rpm, 795rpm, 1250rpm and1980rpm, 0.08mm/rev, and 0.04mm/rev. Taguchi's technique L8 Orthogonal Array has opted for analyzing the better surface roughness value. Signal to noise ratios also performed for optimum process parameters.

Key Words: Friction drilling, Al6061-T6, Universal Radial Drill, Surfaces roughness, Taguchi's technique, Bush Shape, Bush length

Introduction:

At present all most all mechanical and automobile industries are trying to maintain the weight less components to save energy, and connection between parts of thin sections are plays an important role in manufacturing industries. In traditional drilling process HSS tool was used because it's create high temperature when making holes on workpiece, its leads to shorter life of tool and dull. The other way the chips comprehensible case will cause more surface roughness and more precision [1]. So that there is a need to reach the good tool durability, performance and strength, new technology have been developed is called as Thermal drilling, form drilling, and Friction stair drilling. In this it has a productive technology which allows creating holes on sheet metals with bushing for thread connection, the working principal for form drilling is rotating tool is comes to contact with the work material, heats the work material to plastic stage because of frictional and axial force it forms the hole and bushing on work material. This process is friendlier to environment compare to conventional drilling. Latif Özler[2] performed experiment on AISI 1010 square tube with constant and varying feed rates for examine the surface roughness and bush of the hole, results shows that bushing height and workpiece temperature was increased with variable feed, there is no difference in petal formation with the two low feed rates. Scott F. Miller et.al [3]. Performed friction drilling Thermo-Mechanical FEM to investigate work material deformation and plastic strain in work material, and the results compared with experimental results of temperature, torque, and thrust force. S.-M. Lee et.al [4]. Has conducted the experiment with different speeds on of IN-713LC Cast Super alloy with Friction Drilling. Different feed rates and speed for evaluating the various Material behavior including surface roughness (Ra), roundness, and hardness. Results shows that smoother Ra and better roundness will get with increasing of speed and feed, hardness is more at walls of the hole. Scott F. Miller et.al: [5]. Investigated the tool wear in FD on low carbon steels, Al and Mg with the help of CMM, depending of on the detecting changes, shape, and weight change tool wear can measured, with the help of SEM wear damages can be observed. Its shows that WC tool is get more life and minimum wear occurred at 11,000 holes, with respective that chemical changes are analyzed by using Energy dispersive spectrometry, and explored relation between axial force and torque. Mehmet Tuncay Kaya et.al [6] explore effect process parameters such as FA, FCAR, speed and feed on workpiece ST12 material, by using WC tool coated with TiN treatment. It shows that when increasing of FA, FCAR& Feed rate, torque and thrust force is increased, because of spindle speed surface temperature will effect, surface temperature will increase with increasing of speed. Shin Min Lee et.al [7] investigate hole making on AISI 304 stainless steel by using coated and uncoated WC tool bit, because it have less thermal conductivity, more hardness and high ductility. With the help of physical vapor deposition method WC tool were coated with TiAIN and AlCrN, under different speeds toll performance was observed and measured tool wear, surface temperature and thrust force during process. It proven that less tool wear occurred at low thrust force, but with the effect of lubricating the coated AlCrN will produce more surface temperature. M.Boopathi [8] investigated the effect of process parameters like at affected areas, thrust forces, microscopic observations on Al, brass, and stainless steel in friction drilling

process, at various speeds temperature distribution also measured. It shows that increment of feed rate will cause gradual increment of thrust force, microscopic observations ravels that adhesion of work and material transfer will cause with Aluminum material. Zülküf Demir et.al. [9] Investigates friction drilling operation on A7075-T651 aluminum alloy with the help of pre-drilling friction drilling technique to improve bush shape. And at same time measured surface roughness, by using thermocouples frictional heat has measured at different speeds and feed rates. Results revels that better bush shape was getting with pre-drilling friction drilling technique as compared to normal process, surface roughness will increase or decreased with respective of speed and feed rates increase and decrease. Scott F. Miller Rui Li et.al. [10] Performed Friction Drilling Process on AISI 1020 steel for that employed two methods first one thermal finite element model for tool traveling distance before reaching the work material and second one is force model for evaluating the torque, temperature and axial force. Latif Ozler et.al. [11] done the friction drilling operation on AISI 1010 steel on CNC machine with tungsten carbide drill bit with different friction angles of tool, in this process effect with various parameters on bushing height, temperature at hole zone, washer geometry, petal geometry and thrust force were observed with respective FA, speed and Feed.

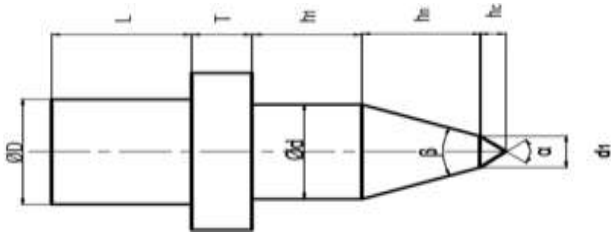


Figure 1(a) Geometry friction drilling tool

1.2 Methodology

In friction drilling process, there are many steps involved for making a hole. Initially when a rotating drilling tool is in contact with a workpiece large amount of heat is generated. Due to this generated heat, the workpiece is melted and the tool penetrated into the workpiece. The penetrated tool formed a cylindrical hole without removing the material. The melted material formed a bush below the workpiece by penetrating the tool and a collar is formed above the workpiece by pressing the shoulder region. After forming the collar, the tool is removed from the workpiece.

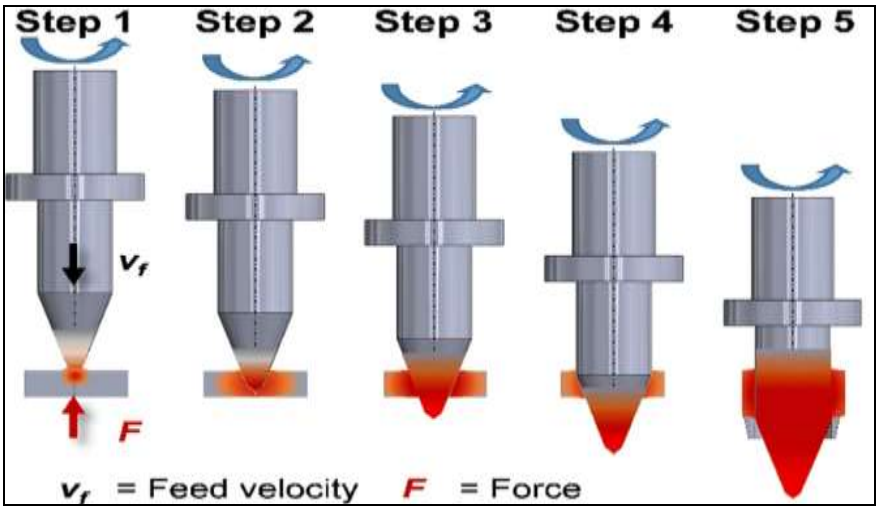


Fig-1(b) Illustration of stages in friction drilling

II. EXPRIMENTAL SETUPAND MATERIALS

The experiment was performed using Universal Radial Drilling Machine SMT-R-2/12/97 on Al 6061-T6 alloy of dimensions 30X10X3mm by using friction drilling tools of Tungsten Carbide and High-Speed Steels. The properties of the work piece and workpiece chemical compositionpiece are given in Tables 1 and 2. The friction drilling operation was performed using speeds of 495rpm, 795rpm, 1250rpm and 1980rpm for every drilling tool. Friction drilling setup has shown in fig.2(a).

Table 1 Chemical combination of Al6061-T6

Al	Cr	Cu	Fe	Mg	Mn	Si	Ti	Zn
95.8	0.04	0.40	0.70	1.2	0.15	0.40	0.15	0.25

Table 2 represents Properties of Al 6061-T6 Parameters

Parameters	Values
Tensile strength	310Mpa
Yield strength	276Mpa
Poisson's ratio	0.33
Elongation	17%
Hardness	105 HB
Thermal Conductivity	167W/m-K

Fig. 2(a) Universal Radial Drilling Machine. Figure 2(b) Experimental setup (high speed 3 axis vertical CNC machine)

In this friction drilling process how the process parameters like bush formation, circularity, surface roughness, thrust force, torque and temperature at hole zone will effect with respective to speed and feed. Bushing formation and depth of hole is two important points in FD, in this experiment petal formation, surface roughness and bush length was observed on Al 6061-T6 material of thickness 3mm. [12]. In this experiment Tungstencarbide & HSS tool are used to produce ahole on Al 6061-T6as shown below Fig.2 (b).Fig.2(c) &Fig.2 (d).

Fig.2(b). WC with Ø8mm

Fig.2(c). HSS with Ø8mm

Fig.2(d). HSS withØ6mm

With the help of the tools, holes were friction drilled individually for 18 holes on each of the Al6061-T6 plates varying tools and parameters of speed which are as shown in the Fig 2(e), 2(f) & 2(g).

Fig.2(e). Friction drilled with WC Ø8mmtool

Fig.2(f). Friction drilled with HSS (Ø8mm)

Fig.2(g). Al 6061-T6Friction drilled with HSS(Ø6mm)

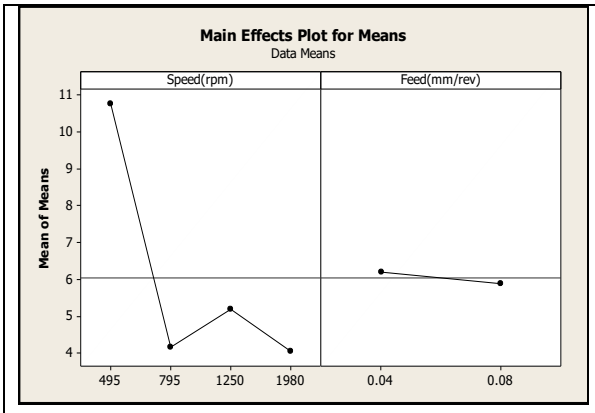
III. RESULTS AND DISCUSSIONS

3.1. INVESTIGATION OF SURFACE ROUGHNESS (RA)

Here in this stage how the process parameters like speed and feed will effect shape of bush has been studied on Al6061-T6. In this by observation is made with by varying feed and spindle speed on bush formation.The temperature were decreased at high spindle speed. The work piece is start melting at stage 2 at work piece come and contact with the workpiece, in stage 1 tool tip is contact with Al6061-T6 material. With help of Mltutoyo SURFTEST SJ.310 we collect surface roughness values with help of that results graph are generated by using Minitab software, figure 3,4 & 5 shows that parameters influence on surface roughness. From that it shows with height speed and feed rates will get finer surface roughness. Finer surface roughness will get with HSS tool, as for speed and federates of 1980rpm and 0.08mm/rev the surface roughness values will be for WC, HSS (Ø8mm) & HSS (Ø6mm) was 2.6 μm 1.7 μm & 3.4 μm. And at for low speed and feed rates of 495rpm, federate of 0.04 mm/rev surface roughness values will be for WC, HSS (Ø8mm) & HSS (Ø6mm) was 11.1 μm 9.4 μm &10.6 μm. With increased temperature stress between tool and work material will decreased, as of that coefficient of friction and Ra mayreduced [13, 14& 15].

3.2. INVESTIGATION OF BUSH LENGTH (BL)

In this paper addressed the bushing length that will be effected by process parameters. The bushing length is measured with the help of venire depth gauge, the graph shows that bushing length is increased with increasing of spindle speed. The fig 3,4,&5 shows that relation between speed and bushing height when speed increases the friction between workpiece and toll is also increase, then the work material will become soften. When feed rate is less bad bushing length will occurred, because of increasing of feed rate uniform frictional heat will distributed. On the other thing the material thickness will also another parameter for bushing formation, based on material bushing forms,



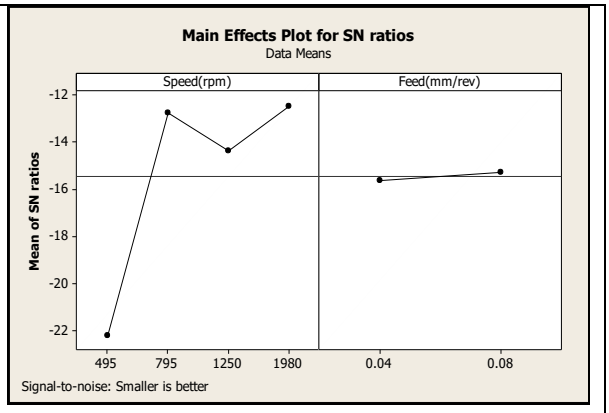
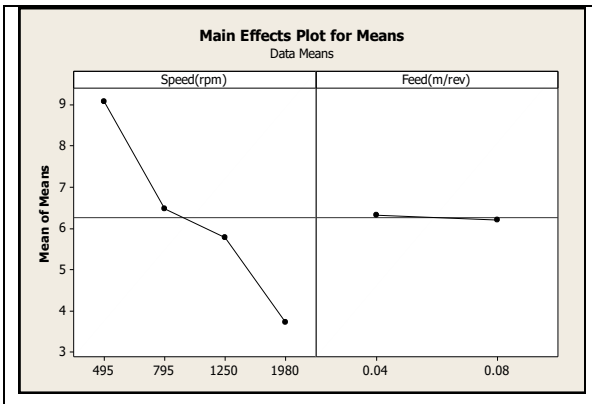


Fig. 3. Effect of BL and Surface roughness with WC tool



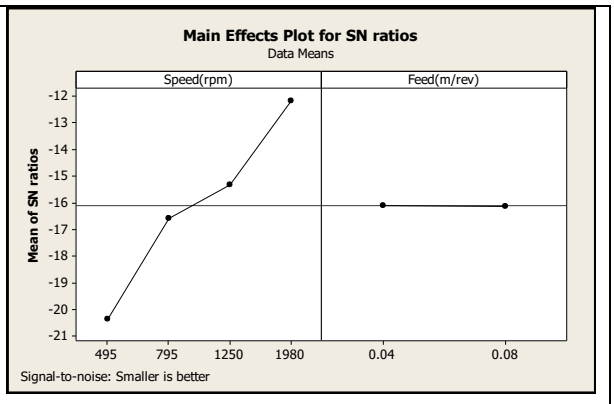
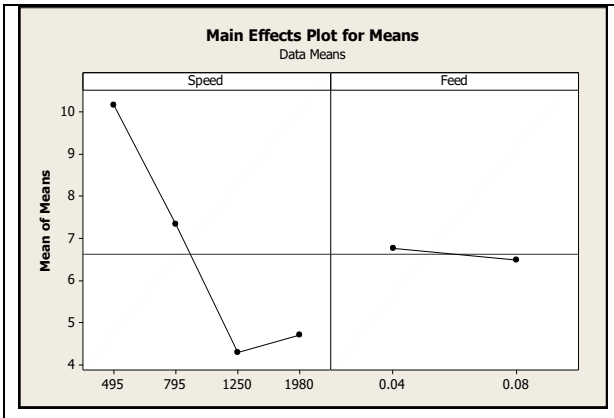


Fig. 4. Effect of BL and Surface roughness with HSS (Ø8mm) Tool



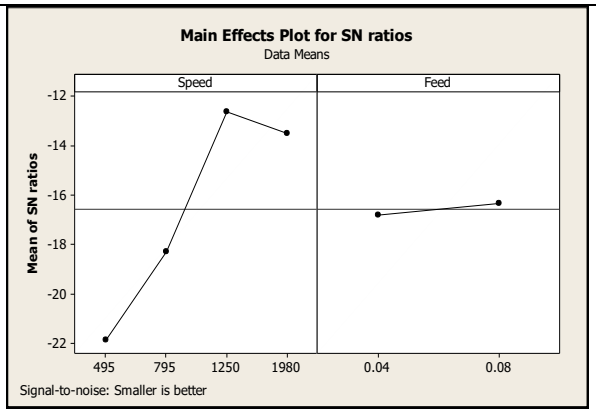


Fig. 5. Effect of BL and Surface roughness with HSS (Ø6mm) Tool

IV. SHAPE OF BUSHING

There are two major things in the to evaluate the hole in friction drilling, one is based on circularity of hole, formation of petal, roughness, thickness of bush these are the various things to judge the shape of bushing.It was observed that the proper bush formation will occurred at medium speed and maximum feed rates, as compared to max speeds better to maintain maintain medium speeds to get better bush formation


Fig.5.1 (a) HSS with Ø8mm Tool on Al6061-T6


Fig.5.1(b) WC with Ø8mm Tool on Al6061-T6

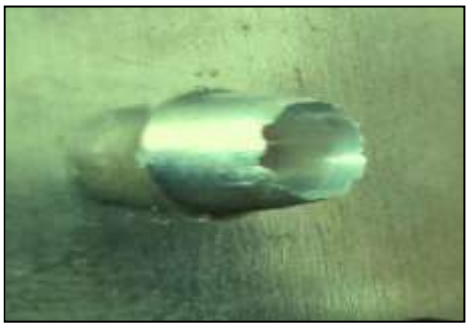



Fig. 5.1(c) HSS with Ø6mm Tool on Al6061-T6

V. CONCLUSIONS

On Al6061-T6 FD was done, formation of bushing was the main problem in Friction drilling. The following results was obtained as per the experimentation, as increasing of feed rate surface roughness will decreases, at the same time friction generation between work material and drill bit distributed uniformly, and soften the work material, higher temperature generated in friction drilling process is 1/2, to 2/3 of work material melting temperature. At speed of 1980rpm and federate of 0.08mm/rev will get better surface roughness for HSS tool as compared to WC. Better bushing length will occurred at maximum speed with high federate. Generally the length of the bushing is 3 times of work material thickness, and influence of process parameters max bushing length will occur at speed of 1980rpm at feed rate of 0.08mm/rev.

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