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Optimization of Tool Parameters on Temperature in Friction Drilling

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ABSTRACT: *Friction drilling is a nontraditional hollow making system in which a conical rotating tool is done to penetrate into workpiece and create the hollow in a single step, with out generating chips. The gadget relies at the warm temperature generated due to the frictional pressure among tool and workpiece, to melt, penetrate and distort the art work fabric into a bushing form. In this task we designed entire friction drilling assembly fashions with one-of-a-type device angles by using using the use of cad device (creo-2.O) proper right here we took forty five attitude tool as an present tool and we additionally designed three extra gear (30 mindset, 60angle, 75 perspective). After designing proper here we analysing every device meeting with static and thermal loading situations through manner of way of using cae tool (Ansys workbench) proper right here we took metal material for device and al-6061 fabric for plate in every case.*

Key words: (creo, Ansys workbench, al-6061, steel, tools with different angles, al-6061 plate.)

INTRODUCTION

Drilling is a lowering system that uses a drill bit to lessen a hole of spherical skip-segment in solid substances. The drill bit is often a rotary decreasing device, often multi-factor. The bit is pressed toward the paintings-piece and grew to become round at prices from hundreds to hundreds of revolutions consistent with minute. This forces the lowering component closer to the paintings-piece, reducing off chips (swarf) from the hollow as it's miles drilled.

In rock drilling, the hollow is typically now not made via a spherical reducing motion, even though the bit is generally grew to become round. Instead, the hole is generally made thru hammering a drill bit into the hollow with rapid repeated short moves. The hammering movement may be achieved from outside the hole (top-hammer drill) or inside the hollow (down-the-hole drill, DTH). Drills used for horizontal drilling are called drifter drills.

In uncommon cases, especially-formed bits are used to lessen holes of non-round drift-section; a square pass-section is viable.

Drilled holes are characterised via their sharp aspect on the entrance issue and the presence of burrs on the go out factor (until they have been removed). Also, the interior of the hollow typically has helical feed marks.

Drilling may also have an effect at the mechanical homes of the workpiece via manner of making low residual stresses throughout the hollow starting and a totally thin layer of rather compelled and disturbed material at the newly fashioned ground. This motives the workpiece to become extra prone to corrosion and crack propagation on the compelled ground. A stop operation may be finished to avoid the ones negative situations. For fluted drill bits, any chips are eliminated through the flutes. Chips also can form long spirals or small flakes, counting on the cloth, and device parameters. The shape of chips normal may be an indicator of the machinability of the material, with prolonged chips suggesting proper material machinability. When viable drilled holes must be positioned perpendicular to the workpiece ground. This minimizes the drill bit's tendency to "stroll", this is, to be deflected from the supposed center-line of the bore, causing the hole to be out of vicinity. The better the period-to-diameter ratio of the drill bit, the more the tendency to walk. The tendency to walk is likewise preempted in severa one in every of a kind techniques, which encompass:

• Establishing a centering mark or characteristic earlier than drilling, which include by using using:

• Casting, molding, or forging a mark into the workpiece

• Center punching

• Spot drilling (i.E., middle drilling)

• Spot going through, this is machining a excessive excellent place on a casting or forging to installation an successfully positioned face on an otherwise rough floor.

- Constraining the location of the drill bit the use of a drill jig with drill bushings

Surface give up produced with the useful resource of drilling may additionally moreover variety from 32 to 500 microinches. Finish cuts will generate surfaces close to 32 microinches, and roughing may be close to 500 microinches.

Cutting fluid is usually used to relax the drill bit, boom tool lifestyles, boom speeds and feeds, increase the ground end, and useful aid in ejecting chips. Application of those fluids is normally achieved through flooding the workpiece with coolant and lubricant or via using a twig mist.

In identifying which drill(s) to apply it's miles important to recall the undertaking on hand and look at which drill may additionally wonderful accomplish the undertaking. There are a spread of drill styles that every serve a first-rate purpose. The subland drill is capable of drilling a couple of diameter. The spade drill is used to drill large hollow sizes. The indexable drill is beneficial in handling chips

Under regular utilization, swarf is carried up and a protracted manner from the top of the drill bit via the fluting of the drill bit. The decreasing edges produce more chips which preserve the motion of the chips outwards from the hollow. This is a fulfillment until the chips percentage too tightly, both because of deeper than regular holes or inadequate backing off (disposing of the drill slightly or completely from the hole at the same time as drilling). Cutting fluid is now and again used to ease this hassle and to lengthen the tool's lifestyles via using cooling and lubricating the top and chip drift. Coolant may be introduced through holes via the drill shank, this is common at the same time as the usage of a gun drill. When lowering aluminum particularly, reducing fluid permits make certain a clean and accurate hollow at the equal time as stopping the metal from grabbing the drill bit inside the way of drilling the hole. When reducing brass, and one among a kind mild metals that may draw near the drill bit and reasons "chatter", a face of approx. 1-2 millimeters can be floor on the reducing facet to create an obtuse perspective of 91 to ninety three stages. This prevents "chatter" at some point of which the drill tears in preference to cuts the metallic. However, with that form of bit reducing element, the drill is pushing the metal away, in preference to grabbing the metallic. This creates immoderate friction and specifically warm swarf.

For heavy feeds and comparatively deep holes oil-hollow drills are used inside the drill bit, with a lubricant pumped to the drill head through a small hole inside the bit and flowing out alongside the fluting. A conventional drill press affiliation may be utilized in oil-hole drilling, but it's far more generally visible in computerized drilling machinery in which it is the workpiece that rotates in desire to the drill bit.

In computer numerical manage (CNC) tool equipment a method known as p.C. Drilling, or interrupted lessen drilling, is used to maintain swarf from detrimentally building up while drilling deep holes (approximately at the identical time as the depth of the hollow is 3 instances extra than the drill diameter). Peck drilling entails plunging the drill component way thru the workpiece, no extra than five times the diameter of the drill, and then retracting it to the ground. This is repeated until the hole is finished. A changed form of this method, known as immoderate pace % drilling or chip breaking, satisfactory retracts the drill barely. This manner is quicker, but is handiest carried out in quite lengthy holes, in any other case it's going to overheat the drill bit. It is likewise used while drilling stringy material to break the chips.

When it is not viable to supply cloth to the CNC device, a Magnetic Base Drilling Machine may be used. The base allows drilling in a horizontal function or perhaps on a ceiling. Usually for these machines it's miles higher to apply cutters due to the fact they may drill lots faster with much less pace. Cutter sizes range from 12mm to 200mm DIA and from 30mm to 200mm DOC(intensity of lessen). These machines are broadly implemented in creation, fabrication, marine, and oil & gas industries. In the oil and gas employer, pneumatic magnetic drilling machines are used to keep away from sparks, further to particular tube magnetic drilling machines that can be fixed on pipes of numerous sizes, even internal.

LITERATUURE REVIEW:

El-Sonbaty et al., [1] executed the drilling experiment with twist drills of diameter 8, 9, 10, eleven, 12 and 13 mm so as to investigate the effect of drill length over thrust and torque inside the drilling of glass fiber bolstered plastic. The regular velocity of 875 rpm changed into used. The feed costs of 0.1, zero.23 and zero.Five mm/rev have been considered. They diagnosed that, the thrust and torque will boom with growth in drill diameter due to the increment inside the shear region. They additionally noticed elevation in thrust stress and torque due to the truth the spindle pace and feed rate will boom.

Bhatnagar et al., [2] from their test done at the composite laminate of glass fiber reinforced plastic, recognized that the 8 issue and Jo-drills produce the lower thrust strain and toque. Hence, they recommended the usage of these drills inside the drilling of composite substances. The experimental outcomes screen that the drill with particular geometry at the facet of middle drills, multifaceted drills, candle stick drills, parabolic drills and so on., with amendment of drill geometry which includes chisel period, rake, clearance, issue and helix attitude are preferred whilst the drilling operation accomplished with the tungsten carbide equipment. Standard twist drill and unique geometry drills carry out similarly in case of HSS drills.

Lachaud et al., [3] completed the drilling experiments over the polymeric composites if you want to estimate the delamination. They divided the delamination into four classes which encompass delamination throughout get right of entry to of the drill, defects due to drill geometry, harm because of temperature, and harm during the exit of the drill. They determined that, the delamination in the course of get entry to of the drill is not commonly gift. The harm associated with tool geometry is constantly related to the angle most of the reducing issue and the fiber orientation. Friction most of the drill and wall of the hollow is the most cause for the temperature related damages. Delamination within the path of exit might be because of the truth that in this diploma all fibers aren't cut and consequently develops the normal stress which opens the matrix/fiber interface. The authors moreover anticipated that the drills which might be used for the steel lowering are not appropriate for machining of polymeric composites.

The bushing form and the hole intensity are essential requirements to assess the amazing of holes in friction drilling. The form of bushing is positioned and judged

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via cylindricality, cracks, and petal formation.

Crack and petal formation are every unwanted for the thread within the drilled holes. They are horrible inclinations of bushing because of low ductility of fabric. Observed through way of experiments, the style of petals is related to the ratio of the workpiece thickness t and the drill bit diameter d. With the identical spindle pace and feed price, the shape of bushing will become greater high-quality and cylindrical, because the workpiece temperature will boom. The notable of the bushing has not anything to do with feed fees experimentally.

The alternate of spindle pace has no huge effect on bushing shape in Al 380 at room temperature. There are nevertheless notable crack and petal formation at maximum spindle pace. However, spindle tempo has lousy consequences on bushing shape in MgAZ91D. At 9 most spindle pace, 15000 rpm, apparent petal formation even layered one is located that is just like the bushing shape at room temperature in Al 380. It concluded that the brittle stable metallic became much less suitable than ductile sheet metal in friction drilling due to wrong bushing shape showing cracks or petal formation [9]. The friction drilled hole geometry become investigated experimentally in AISI 1010 steel square-tube material. The geometry along side the showering device (boss) geometry, the peak of bushing, and the petal geometry grow to be examined with respect to vital spindle speeds and feed fees. The experimental results confirmed the washing device (boss) geometry have become superior through developing spindle speeds, and therefore the height of bushing is prolonged. The decrease in radial forces because of the boom of spindle speeds made tremendous the smoother washer (boss) have end up created due to lots much less impact on washing device geometry. With excessive feed costs, the geometry of washing machine (boss) and the bushing end up distorted. For the purpose, the low temperature due to the advanced thrust forces in excessive feed costs results the bathing machine geometry at the progressed ruptures. In the analysis of the bushing form, the bushing duration, petals, and the bushing hemlines are investigated. As the spindle pace will boom, the bushing length extends, and plenty less petal formation at the bushing hemline is tested. Compared to the spindle pace impact, the impact of feed fee on the bushing period is small. Nevertheless, the bushing length is placed decreased inside the immoderate feed fee operation. At the decrease hole vicinity temperature, the deformation hardening on the workpiece is due to the quick deformation inside the excessive feed fee situation. Therefore, the extrusion length reduces, and similarly petals are generated [5]. Pre-drilling friction drilling became investigated as a unique approach for improving the bushing shape the usage of A7075-T651 aluminum alloy, it surely is a brittle solid fabric. Due to much less touch vicinity most of the tool and art work fabric, pre-drilling approach introduced on much less temperature boom. Thus, for compensating the temperature deficiency in pre-drilling friction drilling procedure, better spindle pace and decrease feed rate are inevitable to benefit extra rotational cycles for generating greater friction warmth. With the popular spindle tempo and feed price, the ground roughness decreased due to the truth the diameter of the pre-drilling hole extended. To determine the super of bushing shape, the cracks and petal formation have been decided removed in pre-drilling friction drilling technique. With the bigger pre-drilling diameter, the shape of bushing together with cylindricality, cracks, and petal formation have been superior [6].

Mechanical properties:

Young’s modulus

Young's modulus, also known as the tensile modulus or elastic modulus, is a mechanical property of linear elastic solid materials. It measures the force (per unit area) that is needed to stretch (or compress) a material sample.

Young's modulus is named after the 19th-century British scientist Thomas Young. However, the concept was developed in 1727 by Leonhard Euler, and the first experiments that used the concept of Young's modulus in its current form were performed by the Italian scientist Giordano Riccati in 1782, pre-dating Young's work by 25 years. The term modulus is the diminutive of the Latin term modus which means measure.

A solid body deforms when a load is applied to it. If the material is elastic, the body returns to its original shape after the load is removed. The material is linear if the ratio of load to deformation remains constant during the loading process. Not many materials are linear and elastic beyond a small amount of deformation. A constant Young's modulus applies only to linear elastic materials. A rigid material has an infinite Young's modulus because an infinite force is needed to deform such a material. A material whose Young's modulus is very high can be approximated as rigid.

A stiff material needs more force to deform compared to a soft material. Therefore, the Young's modulus is a measure of the stiffness of a solid material. Do not confuse:

- stiffness and strength: the strength of material is the amount of force it can withstand and still recover its original shape;
- material stiffness and geometric stiffness: the geometric stiffness depends on shape, e.g. the stiffness of an I beam is much higher than that of a spring made of the same steel thus having the same rigidity;
- stiffness and hardness: the hardness of a material defines the relative resistance that its surface imposes against the penetration of a harder body;
- Stiffness and toughness: toughness is the amount of energy that a material can absorb before fracturing.

Young's modulus is the ratio of stress (which has units of pressure) to strain (which is dimensionless), and so Young's modulus has units of pressure. Its SI unit is therefore the Pascal (Pa or N/m^2 or $m^{-1}\cdot kg\cdot s^{-2}$). The practical units used are mega Pascal's (MPa or N/mm^2) or (GPa or kN/mm^2). In United States customary units, it is expressed as pounds (force) per square inch (psi). The abbreviation ksi refers to "kpsi", or thousands of pounds per square inch.

The Young's modulus enables the calculation of the change in the dimension of a bar made of an isotropic elastic material under tensile or compressive loads. For instance, it predicts how much a material sample extends under tension or shortens under compression. The Young's modulus directly applies to cases uniaxial stress, that is tensile or compressive stress in one direction and no stress in the other directions. Young's modulus is also used in order to predict the deflection that will occur

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in a statically determinatebeam when a load is applied at a point in between the beam's supports. Other elastic calculations usually require the use of one additional elastic property, such as the shear modulus, bulk modulus or Poisson's ratio. Any two of these parameters are sufficient to fully describe elasticity in an isotropic material.

Young's modulus, E, can be calculated by dividing the tensile stress by the extensional strain in the elastic (initial, linear) portion of the stress–strain curve:

$$E \equiv \frac{\text{tensile stress}}{\text{extensional strain}} = \frac{\sigma}{\varepsilon} = \frac{F/A_0}{\Delta L/L_0} = \frac{FL_0}{A_0 \Delta L}$$

where

E is the Young's modulus (modulus of elasticity)

F is the force exerted on an object under tension;

A_0 is the original cross-sectional area through which the force is applied;

ΔL is the amount by which the length of the object changes;

L_0 is the original length of the object.

Poison's ratio:

Poisson's ratio, named after Siméon Poisson, is the negative ratio of transverse to axial strain. When a material is compressed in one direction, it usually tends to expand in the other two directions perpendicular to the direction of compression. This phenomenon is called the Poisson effect. Poisson's ratio ν (nu) is a measure of this effect. The Poisson ratio is the fraction (or percent) of expansion divided by the fraction (or percent) of compression, for small values of these changes.

Conversely, if the material is stretched rather than compressed, it usually tends to contract in the directions transverse to the direction of stretching. This is a common observation when a rubber band is stretched, when it becomes noticeably thinner. Again, the Poisson ratio will be the ratio of relative contraction to relative expansion, and will have the same value as above. In certain rare cases, a material will actually shrink in the transverse direction when compressed (or expand when stretched) which will yield a negative value of the Poisson ratio.

The Poisson's ratio of a stable, isotropic, linear elastic material cannot be less than −1.0 nor greater than 0.5 due to the requirement that Young's modulus, the shear modulus and bulk modulus have positive values. Most materials have Poisson's ratio values ranging between 0.0 and 0.5. A perfectly incompressible material deformed elastically at small strains would have a Poisson's ratio of exactly 0.5. Most steels and rigid polymers when used within their design limits (before yield) exhibit values of about 0.3, increasing to 0.5 for post-yield deformation (Seismic Performance of Steel-Encased Concrete Piles by RJT Park) (which occurs largely at constant volume.) Rubber has a Poisson ratio of nearly 0.5. Cork's Poisson ratio is close to 0: showing very little lateral expansion when compressed. Some materials, mostly polymer foams, have a negative Poisson's ratio; if these auxetic materials are stretched in one direction, they become thicker in perpendicular direction. Some anisotropic materials have one or more Poisson ratios above 0.5 in some directions.

Assuming that the material is stretched or compressed along the axial direction (the x axis in the below diagram):

$$\nu = -\frac{d\varepsilon_{\mathrm{trans}}}{d\varepsilon_{\mathrm{axial}}} = -\frac{d\varepsilon_{\mathrm{y}}}{d\varepsilon_{\mathrm{x}}} = -\frac{d\varepsilon_{\mathrm{z}}}{d\varepsilon_{\mathrm{x}}}$$

where

ν is the resulting Poisson's ratio,

$\varepsilon_{\mathrm{trans}}$ is transverse strain (negative for axial tension (stretching), positive for axial compression)

$\varepsilon_{\mathrm{axial}}$ is axial strain (positive for axial tension, negative for axial compression).

Yield strength:

A yield strength or yield point of a material is defined in engineering and materials science as the stress at which a material begins to deform plastically. Prior to the yield point the material will

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deform elastically and will return to its original shape when the applied stress is removed. Once the yield point is passed, some fraction of the deformation will be permanent and non-reversible. In the three-dimensional space of the principal stresses ($\sigma_1, \sigma_2, \sigma_3$), an infinite number of yield points form together a yield surface.

Knowledge of the yield point is vital when designing a component since it generally represents an upper limit to the load that can be applied. It is also important for the control of many materials production techniques such as forging, rolling, or pressing. In structural engineering, this is a soft failure mode which does not normally cause catastrophic failure or ultimate failure unless it accelerates buckling.

It is often difficult to precisely define yielding due to the wide variety of stress–strain curves exhibited by real materials. In addition, there are several possible ways to define yielding:

True elastic limit

The lowest stress at which dislocations move. This definition is rarely used, since dislocations move at very low stresses, and detecting such movement is very difficult.

Proportionality limit

Up to this amount of stress, stress is proportional to strain (Hooke's law), so the stress-strain graph is a straight line, and the gradient will be equal to the elastic modulus of the material.

Elastic limit (yield strength)

Beyond the elastic limit, permanent deformation will occur. The elastic limit is therefore the lowest stress at which permanent deformation can be measured. This requires a manual load-unload procedure, and the accuracy is critically dependent on the equipment used and operator skill. For elastomers, such as rubber, the elastic limit is much larger than the proportionality limit. Also, precise strain measurements have shown that plastic strain begins at low stresses.

Yield point

The point in the stress-strain curve at which the curve levels off and plastic deformation begins to occur.

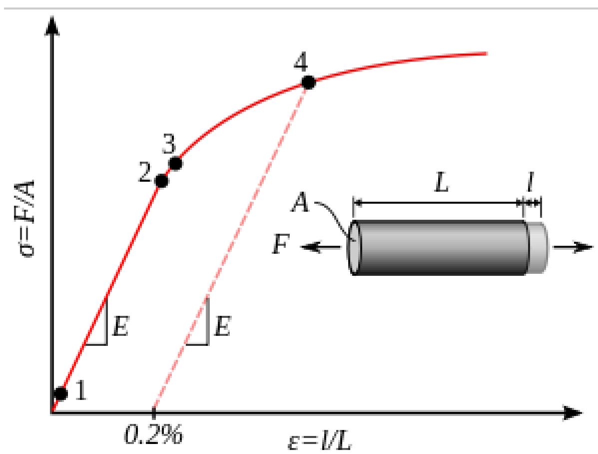
Offset yield point (proof stress)

When a yield point is not easily defined based on the shape of the stress-strain curve an offset yield point is arbitrarily defined.

The value for this is commonly set at 0.1 or 0.2% plastic strain.[The offset value is given as a subscript, e.g., $R_{p0.2}$=310 MPa. High strength steel and aluminum alloys do not exhibit a yield point, so this offset yield point is used on these materials

Upper and lower yield points

Some metals, such as mild steel, reach an upper yield point before dropping rapidly to a lower yield point. The material response is linear up until the upper yield point, but the lower yield point is used in structural engineering as a conservative value. If a metal is only stressed to the upper yield point, and beyond, Lüders bands can develop



Stress–strain curve showing typical **yield** behavior for nonferrous alloys. (Stress (σ) shown as a function of strain (ϵ).)

1: True elastic limit
2: Proportionality limit
3: Elastic limit
4: Offset yield strength

Steel

Carbon	**0.16-0.18%**
Silicon	**0.40% max**
Manganese	**0.70-0.90%**

Sulphur	**0.040% Max**
Phosphorus	**0.040% Max**
steel	**Remaining %**

Steel has excellent weldability and produces a uniform and harder case and it is considered as the best steel for carburized parts. Steel offers a good balance of toughness, strength and ductility. Provided with higher mechanical properties, hot rolled steel also includes improved machining characteristics and Brunel hardness.

Specific manufacturing controls are used for surface preparation, chemical composition, rolling and heating processes. All these processes develop a supreme quality product that are suited to fabrication processes such as welding, forging, drilling, machining, cold drawing and heat treating.

Weldability

Steel can be instantly welded by all the conventional welding processes. Welding is not recommended for steel when it is carbo-nitride and carburized.

Low carbon welding electrodes are to be used in the welding procedure, and post-heating and pre-heating are not necessary. Pre-heating can be performed for sections over 50 mm. Post-weld stress relieving also has its own beneficial aspects like the pre-heating process.

Heat Treatment

The heat treatment for steel consists of the following processes:

Normalizing

- Steel should be heated at 890°C – 940°C and then cooled in still air.

Forging

- This process requires heating between 1150°C – 1280°C and Steel is held until the temperature becomes constant.
- 900°C is the minimum temperature required for the forging process.

- The steel is then cooled in air after this process.

Tempering

- Steel is tempered at between 150°C – 200°C for improvement of case toughness. This process has little or no effect on hardness.
- The occurrence of grinding cracks is reduced when Steel is tempered at the above mentioned temperature.

Annealing

- The Steel is heated at 870°C – 910°C and allowed to cool in a furnace

Stress Relieving

- 500°C – 700°C is required to relieve stress in Steel that is later cooled down in still air.

Case Hardening

- This process requires heating to be carried out between 780°C – 820°C. Steel is then quenched in water.

Core Refining

- This is an optional process that requires heating at 880°C – 920°C.
- Steel after being heated is moistened in oil or water.

Carburizing

- Carburizing takes place at 880°C – 920°C.

Applications of Mild Steel

- It is used in bending, crimping and swaging processes.
- Carburized parts that include worms, gears, pins, dowels, non-critical components of tool and die sets, tool holders, pinions, machine parts, ratchets, dowels and chain pins use Mild steel.
- It is widely used for fixtures, mounting plates and spacers.
- It is suitably used in applications that do not need high strength of alloy steels and high carbon.
- It provides high surface hardness and a soft core to parts that include worms, dogs, pins, liners, machinery parts, special bolts, ratchets, chain pins, oil tool slips, tie rods, anchor pins, studs etc.

- It is used to improve drilling, machining, threading and punching processes.

It is used to prevent cracking in severe bends.

CONCLUSION

In this project we designed complete friction drilling assembly models with different tool angles by using cad tool (creo) here we took 45 angle tool as an existing tool and we also designed 3 more tools (30 angle, 60angle, 75 angle). After designing here we analysing each tool assembly with static and thermal loading conditions by using cae tool (Ansys workbench) here we took steel material for tool and al-6061 material for plate in each case.

From the static results 45 angle tool require 8.8e-2mm/s axial velocity to drill the plate but when replace this tool with 30 angle tool, it requires only 3e-2mm/s axial velocity only, for 60angle tool 3.75e-2mm/s and 75 angle requires 7.5e-2mm/s axial velocity's, from the results here we can say that 30 angle and 60 angle tools required less axial velocity's than other tools by replacing these tools here we can also reduce the power requirement because high velocity's required high amount of power, but we cannot replace our tool by single analysis, to get more accurate values her we performed thermal analysis on it.

From the thermal results here observe that 30 angle tool require less temperature to reach plate melting point, it means it take less time than any other tool because it required lower temperature Values only from all these values we can say 30 angle tool only required less time and reaming tools take some time to reach their melting point

Even though in static results both 30 and 60 angles are required less axial velocity but by comparing both static and thermal results we can replace only 30 angle tool

Finally By replacing our 30 angle tool we can reduce the usage of power and time both.

REFERENCE

[1] France J.E., Davidson J.B. and Kirby P.A. 1999. Strength and rotational stiffness of simple connections to tubular columns using flow drill connectors. J. Constr. Steel Res. 50: 15-34.

[2] Bak D. 1987. Friction, Heat from Integral Bushings. Des. News. 43(11): 124.

[3] Kerkhofs M., Steppen M.V., D Olieslaeger M., Quaeyhaegons C. and Stals

L.M. 1994. The performance of (Ti.Al.) N-Coated Flow drills. Surf. Coat Technology. 68/69: 741-746.

[4] Scot F. Miller. 2006. Experimental and numerical analysis of Friction drilling process. Transactions of ASME, Manuf. Science. 128: 802-810.

[5] Phillip J. Ross. Taguchi Techniques for Quality Engineering. McGraw-Hill.

[6] Kempthore. 1986. Design and analysis of experiments. John Wiley and Sons, New York.

[7] Taguchi G. 1987. Systems of Experimental design. John Wiley and Sons, New York.

[8] Strenkowski J.S., Hsieh C.C. and Shih A. J. 2004. An analytical finite Element Technique for predicting Thrust Force and Torque in Drilling. Int. J. Mach. Tools Manuf. 44: 1413-1421.

[9] Soo. S. L., Aspinwall. D.K., and Dewes R. C., 2004, "3D FE Modeling of the Cutting of Inconel 718," J.Mater. Process.Technol.

[10] CebeliOzek, ZulkufDemir, Investigate the friction Drilling of Aluminium alloys According to the Thermal Conductivity, TEM Journal-volume 2/Number 1/2013.

[11] Pantwane. P. D., Ahuja. 11. B. Experimental investigations and multi-objective optimization of friction drilling process on AISI 1015. Volume 2. No 2. 2011.

[12] DiwakarReddy. V, Krishnaiah. G, Gopichand. A, and Indumathi. Analysis in Form Drilling AA110 using HSS Tools, International Conference on Trends in Mechanical and Industrial Engineering (ICTMIE'2011) Bangkok Dec.. 2011.

[13] Syed Mohibuddin Bukhari and M. Manzoor Hussain, Greener, Evaluation of Optimum Process Parameters in Drilling Process of Hybrid Composites using Taguchi Method. International Journal of Mechanical Engineering and Technology, 8(4), 2017, pp. 194–201.

[14] J. Ganesh, P. Renukadevi and P. Vijayakumar, Experimental Optimization of Drilling Process Parameters on Die Steel (H13) Using Carbide Coated Drill By Taguchi Design Method. International Journal of Mechanical Engineering and Technology, 8(3), 2017, pp. 159–167.

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p-ISSN: 2348-795X
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May 2018

[15] T. Prabhu, A. Arulmurugu, Experimental and Analysis of Friction Drilling on
Aluminium and copper. International Journal of Mechanical Engineering and
Technology (1.1MET), ISSN 0976-63599(online), Volume 5. Issue 5. May (2014). pp.
123-132 © IAEME.