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Optimization of Drilling Parameters of SS305 by Taguchi Method

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Abstract:Drilling operation is widely used in metal cutting industries, although modern metal cutting methods have improved in the manufacturing industries, but conventional drilling still remains one of the most common machining. In this study, focuses on the optimization of drilling parameters using the Taguchi technique to obtain minimum surface roughness (Ra) and hole diameter, cylindricity &Machining timing. A number of drilling experiments were conducted using the L9 orthogonal array on conventional drilling machine. The experiments were performed on SS 304 using HSS, TiN coated & M42 twist drills were used under dry cutting conditions with various end point angle speed and feed. The measured results were collected and analyzed with the help of the commercial software package MINITAB17

Key Words: drilling, Taguchi method, Analysis of Variance, SS305

I.INTRODUCTION

TheHole making is among the most important operations in manufacturing. Drilling is a major and common of hole making process. Drilling is the cutting process of using a drill bit in a drill to cut or enlarge holes in solid materials, such as wood or metal. Different tools and methods are used for drilling depending on the type of material, the size of the hole, the number of holes, and the time to complete the operation. It is most frequently performed in material removal and is used as a preliminary step for many operations, such as reaming, tapping and boring. The cutting process in which a hole is originated or enlarged by means of a multipoint, fluted, end cutting tool. As the drill is rotated and advanced into the work piece, material is removed in the form of chips that move along the fluted shank of the drill.

Although long spiral chips usually result from drilling, adjustment of the feed rate can result in chips with a range of many different shapes and sizes. Material of work piece can also change the range of different chip shapes and sizes generally, the hole diameters produced by drilling are slightly larger than the drill diameter (oversize). The amount of oversize depends on the quality of the drill and also the equipment that used as well as the machinist

IITOOL MATERIAL

Many different materials are used for or on drill bits, depending on the required application. Many hard materials, such as carbides, are much more brittle than steel, and are far more subject to breaking, particularly if the drill is not held at a very constant angle to the work piece; e.g., when hand-held. Soft low-carbonsteelbits are inexpensive, but do not hold an edge well and require frequent sharpening. They are used only for drilling wood; even working withhardwoodsrather thansoftwoodscan noticeably shorten their lifespan. Bits made from high-carbon steel are more durable than lowcarbon steelbits due to the properties conferred byhardening and temperingthe material. If they are overheated (e.g., by frictional heating while drilling) they lose their temper resulting in a soft cutting edge. These bits can be used on wood or metal. High (HSS) is a form of tool; HSS bits are hard and much more resistant to heat than high carbon steel. They can be used to drill metal, this hardwood, and most other materials at greater cutting speeds than carbonsteel bits, and have largely carbon steels. Titanium steelalloysare variations on high-speed steel that contain more cobalt. Them their hardness at much higher temperatures and are used to drillstainless steeland other hard materials. The main disadvantage of cobalt steels is that they are more brittle than standard HSS. carbideand othercarbidesare extremely hard and can drill virtually all materials, while holding an edge longer than other bits. The material is expensive and much more brittle than steels; consequently, they are mainly used for drill-bit tips, small pieces of hard material fixed orbrazedonto the tip of a bit made of less hard metal. However, it is becoming common in job shops to use solid carbide bits. In very small sizes it is difficult to fit carbide tips; in some industries, most notablyPCBmanufacturing, requiring many holes with diameters less than 1 mm, solid carbide bits are used. Stainless steel sections have been increasingly used in architectural and structural applications because of their superior corrosion resistance, ease of maintenance and pleasing appearance. The mechanical properties of stainless steel are quite different from those of carbon steel. For carbon and low-alloy steels, the proportional limit is assumed to be at least 70 % of the yield point, but for stainless steel the proportional limit ranges from approximately 36 % - 60 % of the yield strength. Therefore, the lower proportional limits would affect the buckling behavior of stainless steel structural members. Stainless steel structural members are more expensive

III.PROPOSED SYSTEM AUSTENITIC

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Chromium-nickel-iron alloys with 16-26% chromium, 6-22% nickel (Ni), and low carbon Content, with non-magnetic properties (if annealed - working it at low temperatures, then heated and cooled). Nickel increases corrosion resistance. Harden able by cold-working (worked at low temperatures) as well as tempering (heated then cooled). Type 305 (S30400) or "18/8" (18% chromium 8% nickel), is the most commonly used grade or composition. **Martensitic** Chromium-iron alloys with 10.5-17% chromium and carefully controlled carbon content, harden able by quenching (quickly cooled in water or oil) and tempering (heated then cooled). It has magnetic properties. Commonly used in knives.

Ferrite

Chromium-iron alloys with 17-27% chromium and low carbon content, with magnetic properties. Cooking utensils made of this type contain the higher chromium levels. Type 430 is the most commonly used ferrite. Two additional classes worth mentioning include Duplex (with austenitic and ferrite structures), and Precipitation Hardening stainless steel, used in certain extreme conditions. Austenitic stainless steel is also called 200 and 300 series; stainless steels have an austenitic crystalline structure, which is aface-centered cubiccrystal structure. Austenite steels make up over 70% of total stainless steel production. They contain a maximum of 0.15% carbon, a minimum of 16% chromium, and sufficient nickel and/or manganese to retain an austenitic structure at all temperatures from thecryogenicregion to the melting point of the alloy.

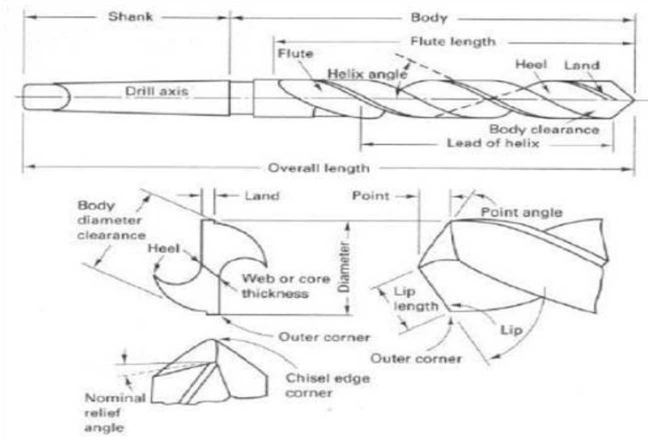
200 Series—austenitic chromium-nickel-manganese alloys. Type 201 is hard enable through cold working; Type 202 is a general purpose stainless steel.

300 Series. The most widely used austenite steel is the305, also known as 18/8 for its composition of 18% chromium and 8% nickel. 304 may be referred to as A2 stainless. The second most common austenite steel is the316grade, also referred to as A4 stainless and called marine grade stainless, used primarily for its increased resistance to corrosion.

PROBLEM IDENTIFICATION

The important goal in the modern industries is to manufacture the products with lower cost and with high quality in short span of time. There are two main practical problems that engineers face in a manufacturing process. The first is to determine the values of process parameters that will yield the desired product quality. Second is to maximize manufacturing system performance using the available resources.

IV.BLOCK DIAGRAM



Drill bits are cutting tools used to create cylindrical holes. Bits held in a tool called a drill, whichrotates them and provides torque and axial force to create the hole. Different point angle drills anddifferent diameter drills and of different length of drills can be used according to the application ofwork. Drills with no point angle are used in situations where a blind, flat-bottomed hole isrequired. These drills are very sensitive to changes in lip angle, and even a slight change can resultin an inappropriately fast cutting drill bit that will suffer premature wear. Diameters range of twistdrill is about 0.15 to 75 mm. Body, Point, and Shank are three basic parts of twist drill twist drillhas two spiral or helical grooves called flutes separated by Lands. Angle of spiral flute is call ashelix angle around 30°. Flutes helps for extraction of from the hole. Web is the thickness of thedrill between the flutes and it support the drill support over its length. Point of the twist drill hasthe general shape of a cone having a typical value of 118°. Point can be design in various ways.However, most common design is a chisel edge. The spiral, or rate of twist in the drill, controls therate of chip removal in a drill. A fast spiral drill is use in high feed rate applications under lowspindle speeds.

V.COMPONENTS ANDTECHNOLOGIES

HSS Drill Bit is a subset oftool steels, commonly used ascutting tool material. It is often used in power-saw blades anddrill bits. It is superior to the older high-carbon steeltools used extensively. It can withstand higher temperatures without losing its temper (hardness). This property allows HSS tocut fasterthan high carbon steel, hence the name high-speed steel. At room temperature, in their generally recommended heat treatment, HSS grades generally display high hardness (aboveRockwell hardness60) and abrasion resistance (generally linked totungstenandvanadiumcontent often used in HSS) compared with commoncarbonand steels. The addition of about 10% of tungsten and molybdenum in total maximizes efficiently the hardness and toughness of high speed steels and maintains those properties at the high temperatures generated when cutting

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metals.

HSS Chemical Composition

HSS drill bit Chemical Composition

Sl No	Carbon	Silicon	Manganese	Chromium	Tungsten	Vanadium
1	2.0	-	2.5	-	7.0	-

HSS Drill Bit

M42 Drill Bit a molybdenum-series high-speed steel alloy with an additional 8% or 10% cobalt. It is widely used in metal manufacturing industries because of its superior redhardness as compared to more conventional high-speed steels, allowing for shorter cycle times in production environments due to higher cutting speeds or from the increase in time between tool changes. M42 is also less prone to chipping when used for interrupted cuts and costs less when compared to the same tool made of carbide. Tools made from cobalt-bearing high speed steels can often be identified by the letters HSS-TiNcoating .

M42 drill bit Chemical Composition

S N0	Carbon	Chromium	Molybdicenemy	Tungstn	Vanedim	Cobalt
1	1.10	3.75	9.50	1.50	1.15	8.00

TIN COATED DRILL

Bit Surface coatings on drill bits allow greater feeds and speeds when operating at higher temperatures, increasing tool life and thus productivity sometimes by 4 or 5 times. Tin (Gold) – Titanium Nitride: A gold colored film of Titanium Nitride with a hardness of approximately 85Rc is deposited on the tool which extends tool life by reducing friction and enables greater speeds and feeds. Lesser quality drills often imitate Tin coating, but more often this is purely cosmetic. Coatings are for use at high speeds where the temperature is high enough to bring the coatings functional use into play**.**

S. No	Carbon	Chromium	Molybee	Vanedim	Maeganese	Silicon
1	2.00	1.75	um-	0.75	3.50	1.82

Tin coated drill bit chemical composition

Tin Coated Drill Bit

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VI.EXPERIMENTATION

The HAAS TM1 Vertical Milling machine was used for experimentation. The twist drill bit was used in machining the work-piece. Preparing the slurry by taking concentration (gm/ml) of 15%, 25%, and 35%, with abrasive powder of Silicon carbide which has grit size 1200 µm. Stop-watch was used to determine material removal rate (MRR). For measuring surface roughness Minutolo (Surftest-4) was used. The corresponding MRR and surface finish was recorded for each experiment.

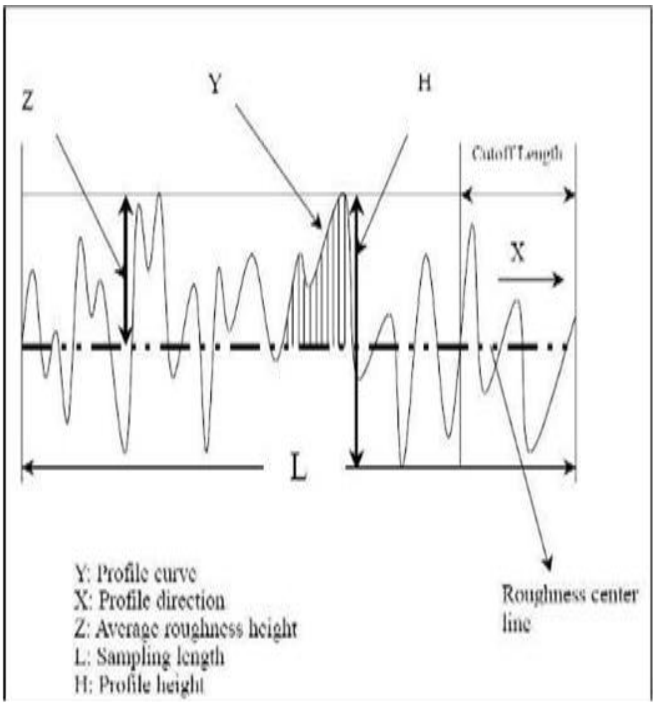
VII.Machining Setup

A VMC is a type of CNC machine, typically enclosed and most often used for cutting metal. They are usually very precise and very expensive. VMC stands for vertical milling center and refers to a particular type of milling machine where the spindle runs in a vertical axis known as the "z" axis. There are two subcategories of vertical mills: the bed mill and the turret mill. A turret mill has a stationary spindle and the table is moved both perpendicular and parallel to the spindle axis to accomplish cutting. This type of machine provides two methods of cutting in the vertical (Z) direction: by raising or lowering the quill, and by moving the knee. In the bed mill, however, the table moves only perpendicular to the spindle's axis, while the spindle itself moves parallel to its own axis.

VIII.Surface Roughness Meter

Rt in just one device. The small roughness meter is especially designed for fast measuring of roughness. The roughness is a term of surface physics that describes unevenness of surface height. The roughness meter works according to the same piezoelectric micro probe principle like the highly accurate laboratory measuring instruments.

The easy handling of the roughness meter as well as the high repetitive accuracy characterizes this device. After touching the button the piezoelectric micro probe of the roughness meter scans the surface within seconds and shows digitally, according to the preselected cut-off length, either the value Ra, Rz, Rq or Rt.For example, engine parts may be exposed to lubricants to prevent potential wear, and these surfaces require precise engineering – at a microscopic level – to ensure that the surface roughness holds enough of the lubricants between the parts under compression, while it is smooth enough not to make metal to metal contact



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IX.Surface Roughness Result

Experiment No	Surface Roughness (microns)			Average surface roughness (microns)
	Trial 1	Trial 2	Trial 3	
1	2.456	2.190	2.197	2.287
2	1.782	1.398	1.358	1.479
3	1.470	1.318	1.293	1.393
4	0.892	0.769	0.834	0.828
5	0.463	0.445	0.434	0.427
6	2.563	2.666	2.038	2.285

X.CONCLUSION

In this study, the Taguchi technique and ANOVA were used to obtain optimal drilling parameters under dry conditions. The experimental results were analyzed using Minitab 17.The following conclusion can be drawn.As a result of the Taguchi experimental trials, it was foundthat the speed is the most significant factor for the surface roughness with contribution percentage of 50% respectively. The optimum process parameter for surface roughness is spindle speed 1, 600rpm, feed rate 3, 0.06 mm/rev and Tool Material 2, M42 drill bit. The optimum parameter for Circularity Error was spindle speed 2, 800rpm, feed rate 1, 0.02 mm/rev and Tool
Material 3, TiN coated drill bit and feed was the most significant factor for Circularity Error with contribution percentage of 47 % respectively. The optimum parameter for Machining timing were spindle speed 3, 1000rpm, feed rate 1, 0.02 mm/rev and Tool Material 2, M42 drill bit and feed was the most significant factor the MT with contribution percentage of 29 % respectively.

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