Improving the Performance of Tool in High Speed Drilling-Review

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ABSTRACT

This paper discusses optimization of heat treatment process by applying Taguchi methods to improve the quality and consistency in the performance of HSS 4241 drill bits T4241 steel is used as the work piece material for carrying out the experimentation to optimize the heat treatment process parameters. In this project work we are going to increase tool life of twist drill tool by its optimization. we changed existing material molybdenum high speed steel (M2) of ground flute twist drill and suggesting best suitable material molybdenum series high speed steel alloy (M42) which performs better than existing material. We select heat treatment cycle to find optimum result. Also for further enhancement we study effect of spindle speed and point angle on twist drill tool. And find optimum spindle speed and point angle. After optimization we increases hardness, improved the tool life and reduces cost per component of twist drill tool.

Keyword - *Taguchi method[1], Twist Drilling tool[2], Heat Treatment Cycle[3], Point Angle[4], Spindle Speed[5].*

1. INTRODUCTION

Drilling is one of the basic machining processes used to create satisfactory surface quality cylindrical holes and it is essential for ship building, automobile, off-highway equipment, railway aerospace etc. In drilling material is removed in the form of chips. Drilling tool is used for drilling operation. Drills are basically used in woodworking, different type of metalworking. Specially designed drills are also used in space missions and other applications. Various types of drill bits are available depending on performance characteristics, surface finish, spindle speed, and accuracy of operation. The spindle of the drill press clamps to the shank of the drill bit via the chuck, allowing transfer of rotation and cutting force/pressure to the drill bit to create a hole via the drill point. During the drilling process, as the interconnections of material particles are destroyed during cutting, the drill bit is exposed to mechanical, thermal, and chemical influences, or wear. The durability and lifetime of the drill bit depends on the drill bit material, the work piece material, operating modes, and, most importantly, the cutting speed. Commonly, a lubricant is used during drilling to dissipate the heat generated during the cutting process

1.1 Drilling Machine:

A Drilling Machine is a style fixed of drill that mounted on the workbench. Drilling tool is used for drilling operation. Drills are basically used in woodworking, different type of metalworking. Specially designed drills are also used in space missions and other applications A Drilling Machine consists of a base, pillar table, spindle, and drill head is driven by motor. The Drilling Machine size is typically measured in terms of swing. Swing is to be called as twice the distance of throat, which is the distance from the center of the spindle to the edge which is to be closed to the pillar.

1.2 Tool Geometry:

Twist drill is used in high feed rate applications under low spindle speed. The portion of the drill which extends from the extreme cutting end to the shank is called as body. Shank is the portion of drill by which drill is held and driven during working. Flutes are the grooves in the body of the drill which provides lips, permit the removal of chips and allow cutting fluid to reach the lips. The middle portion of drill is situated between the roots of the flutes and extending from the point end towards the shank is called as web. The point end of the web consists of chisel edge. Twist drill tool geometry is as shown in figure 1.

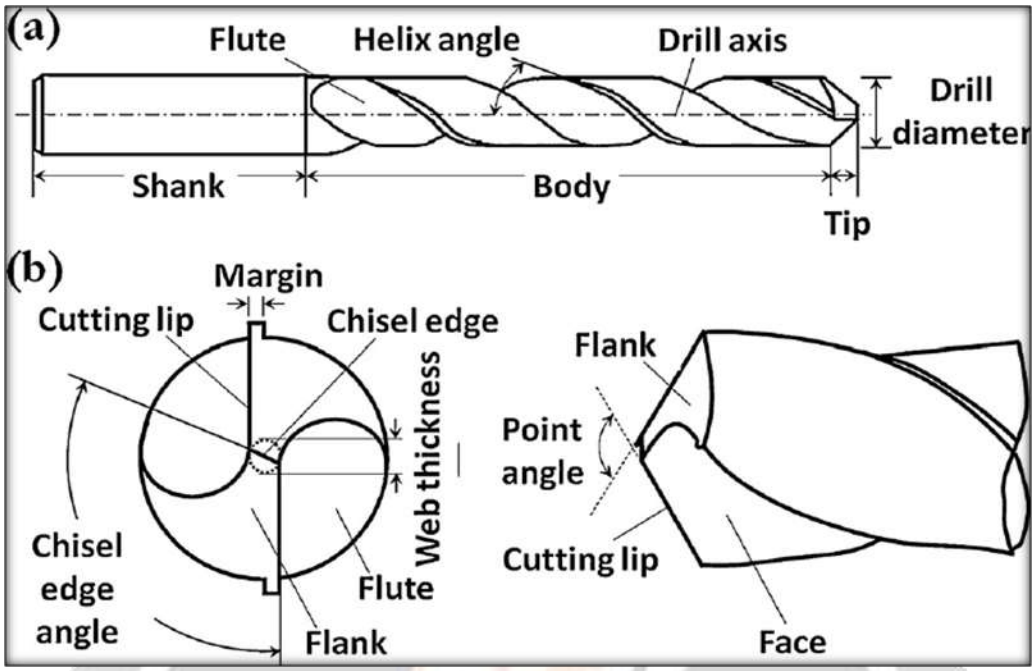

Fig -1: Tool Geometry of Twist Drill

1.3 Literature Survey:

Balakumaran (2015) studied the Taguchi Optimization method for of surface roughness (Ra), according to him machining time and material removal rate of EN31 steel alloy. The experiments carried out by a CNC lathe, utilizing physical vapor deposition coated chromium nitride drilling tool bit for the machining of EN19. The experiments were carried out as per L9 orthogonal array with each test performed under different conditions of such as type of drilling tool, and feed rate. He used Taguchi method and analysis of variance (ANOVA) which was employed by utilizing MINITAB-15 software to identify the calibre of consequentiality of the machining parameters on surface roughness (Ra), machining time and material removal rate (MRR). In his experimental investigation, the Taguchi technique and ANOVA were used to find optimal parameter drilling of EN31 steel under wet conditions. The experimental results were evaluated utilizing ANOVA. [1]

Senthilkumar and Ajiboye (2012) investigated the effect of heat treatment processes on the mechanical properties of medium carbon steel. This paper concluded that mechanical properties depend largely upon the various forms of heat treatment operations and cooling rate. Hence depending upon the properties a suitable form of heat treatment should be adopted for high ductile and minimum annealing, toughness the medium carbon steel will give satisfactory results. Thus it is important to clearly designate the condition of the carbon steel as purchased so that tests can be conducted to ascertain the material compositions before they are put to final use. [2]

Liu et al (2005), studied the effects of heat treatment on two cobalt-predicated alloys, T-400 and T-200. These two alloys were heated in different conditions. The phases and microstructures of the alloys before and after the heat treatments were analyzed utilizing x-ray and scanning electron microscopy. The mechanical and tribological properties of the alloys were investigated utilizing a Nano-indentation technique and a pin-on-disc tribometer, respectively. Cobalt-predicated alloys are consequential wear-resistant materials, especially for high-temperature applications, because of the outstanding properties of the strengthened cobalt solid solution and the hard laves intermetallic phase that make up the alloys. The Laves intermetallic phase is so abundant (35–70 vol. %) in these alloys that its presence governs all of the material properties. Heat treatment alters the volume fraction, the size/shape, and the distribution of the laves phase in the microstructures as well as the phase and structure of the cobalt solid solution, thus influencing the mechanical and tribological properties of the alloys. [3]

Yogendra Tygil (2012) has analyzed drilling of mild steel with CNC drilling machine by using high speed steel tool by applying Taguchi methodology (DOE approach). A L9 array, Taguchi method and analysis of variance (ANOVA) are used to formulate the procedure tried on the change of parameter. Design offers systematic

method of optimization surface finish as well as high material removal rate. 1.3 Problem Definition The cutting tool is one of the important elements in any metal. [4]

1.4 Problem Definition :

The cutting tool is one of the important elements in any metal cutting operation. Over the years the demands of economic competition have motivated a lot of research in the field of metal cutting leading to the evolution of new tool materials of remarkable performance for an impressive increase in productivity. On drilling tool many problems occurs during operations such as breakage, wear, rough surface finish, short tool life etc. This problem is affects finishing of machined products, life of cutting tool and reduces productivity of drilling. Tool material effects on wear of tool during operation and also tool life.

2. EXPERIMENTATION

2.1 Methodology

In this project work we are going to finding best alterative material for drilling tool. This should give highest achievable performance under given constraints.

- Initially we use different combinations of our selected material and different heat treatment and then analyze wear behavior of our selected material test samples by Pin on disc test rig.
- The Steel grade having best wear resistance will be selected for further experimentation. Ground Flute Twist Drill samples to be prepared with the HSS grade steel which is best wear resistant among our selected materials based on wear test result.
- Drilling test will be conducted on EN-9 Steel substrate having hardness of 180-200 BHN to compared performance of existing drills against the drills samples prepared with the new material.

Finally comparison of results between already used material and our selected material.

2.2 Selection of Material

We are selecting high speed steel grade material for our project work. Chemical composition of different steel grade material is as below.

Table -1: Chemical Composition of Selected Material

Material	C	Cr	Mo	V	W	Co
Mo HSS -M2 (used)	0.9	4.1	5	1.8	6.4	_
Co. steel-M35	0.8	4	5	2	6.5	5
Mo. series alloy-M42	1.1	3.9	9.2	1.2	1.4	7.8

2.3 Availability of Testing

2.3.1 Heat Treatment:

- **Hardening** Available at JK Files (India) Ltd, Chiplun.

Fig -2 : Auto Hardening Setup Installed at JKFIL, Chiplun

- **Tempering** Available at JK Files (India) Ltd, Chiplun.

Fig -3: Tempering Process Setup at JKFIL, Chiplun

2.3.2 Endurance Testing Machine: Available at JK Files(India) Ltd, Chiplun

Fig -4: Performance testing machine

2.3.3 Pin on disc apparatus (Wear Test): Available at AVCOE, Sangamner

Fig -5: Pin on disc wear test apparatus

3. OBJECTIVES

Objectives of our project work are as follows: We use different combinations of materials and heat treatment cycles for getting optimum result. Performance of drill depends upon wear rate, before taking actual trial we select different material and different heat treatment cycle and using wear test we select optimum combination develop tool as per specification. To enhance further performance of drill tool we use again different combinations of different spindle speed and point angle, to find better performance of drill on same condition.

4. CONCLUSIONS

It is predicted that Taguchi method is a good technique for optimization of various heat treatment parameters as it reduces the number of experiments. Though there is significant improvement in the performance of Twist Drills, it is still less than that Addison Twist Drills. Twist drills of Addison are manufactured by Roll Forging Technique which is quite costlier. In order to improve performance further, in-house Cryogenic Treatment facility to be installed.

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