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Experimental Analysis Of Coated And Uncoated Twist Drill; Review

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Abstract: Drilling is a process of making hole in a solid body with the help of multipoint cutting tool. Here to improve the life of tool, in order to minimize the production cost, to increase surface roughness different types of coating are applying over it, that coating soft/hard/ soft+ hard. Tool selection depends upon nature of drilling; dry, with coolant. This paper gives review of different coating techniques and its effectiveness by measuring deviation in hole diameter, surface roughness, and wear measurement. A back propagation neural network is preferred instead of radial basis neural network for the prediction of tool wear. It is considered that tool wear depends on cutting speed, feed, thrust force and torque.
Keywords; Surface Coating, triboligical parameters, machining parameters

Introduction:

Drilling processes are widely used in the aerospace, aircraft, and automotive industries. Although modern metal-cutting methods have improved in the manufacturing industry, including electron beam machining, ultrasonic machining, electrolytic machining, and abrasive jet machining, conventional drilling still remains one of the most common machining processes. Worn drills produce poor quality holes and in extreme cases a broken drill can destroy an almost finished part. As it wears, cutting forces will increases, the temperature of the drill rises and this accelerates the physical and chemical processes associated with drill wear and therefore drill wears faster.[3] Experimental studies going on to test feasibility of different types of coating. Zeghni and Hashmi [8] found substrate material has as influence overall tribological properties of composite i.e. deposition of coating not necessarily improve all properties of system. Therefore it is necessary to develop bi-functional coating, it consist of i) hard supportive under layer between substrate and ii) in coating addition of metal into coating matrix. Kao W. H. [7] studied such type of coating properties MoS_2-Cr_x% coating used to adhesion strength, micro hardness, tribological properties and machining performance also. Addition of Cr content in MoS_2 coating increases adhesion strength and micro hardness. MoS_2- Cr5% coated micro drill improve cutting performance in terms of reduced corner wear, increases tool life. Another combination of hard/soft layer i.e. multilayer coating – Hardlube [(Ti,Al)N+WC/C] used for cemented carbide drills. This coating material is a solution when drilling at higher speed. The work piece material is AA2024. Aramcharoen and Mativenga [10] discuss Chromium titanium aluminum nitride (CrTiAlN) is a new advanced development in hard coating materials widely used for drills. the properties of the cutting tool, such as high hardness, toughness, thermal stability and high wear resistance could be improved by adding CrN into TiAlN or vice versa. CrTiAlN coated HSS drills were used to machine EN 9 carbon steel workpiece for more than 200 holes compared to the uncoated. while TiN coated tools only finished about half of CrTiAlN holes. In addition, the drilling performance improved to the level of up to 350 holes when the CrTiAlN drill was coated with MoST. The titanium leads to the improvement of coating adhesion with high hardness. Coating materials of CrTiAlN and CrTiAlN+MoST reduce the workpiece temperature and the tendency of surface hardening for both conventional and high speed machining as compared to uncoated carbide tool. A standard two-flute twist drill has a configuration shown below, Fig.1(a), which includes spiral flutes running along a cylindrical body and the point (drill tip) area. Several research groups developed drill models to formulate mathematical equations that describe the drill geometry, some relying on computer software to generate the drill model. [6]

Experimental setup:

1. Machining conditions

A radial drilling machine (Batliboi Limited, BR618 model) is used for the drilling operation. The process parameters and experimental set-up is as shown in Figs. 1 and 2. A digital type of drill dynamometer used to measure the cutting forces, namely thrust force and torque. For this piezo-electric dynamometer (Kistler type 9272) is used. The parameters that affect tool wear like tool hardness, tool geometry, work piece hardness, temperature and rigidity of machine tool were assumed as constant.[3] The output parameters are deviation in hole diameter, surface roughness, flank wear, number of holes to be drilled.[3,5,9] The maximum flank wear occurs at the outer corner and there is decrease in wear towards the chisel edge corner. The flank wear is measured with the help of optical microscope. The input parameters to be considered are cutting speed, feed, depth of cut, chip thickness. The drilling operation carried in absence of coolant. The schematic diagram for setup is shown in figure 2. [1]

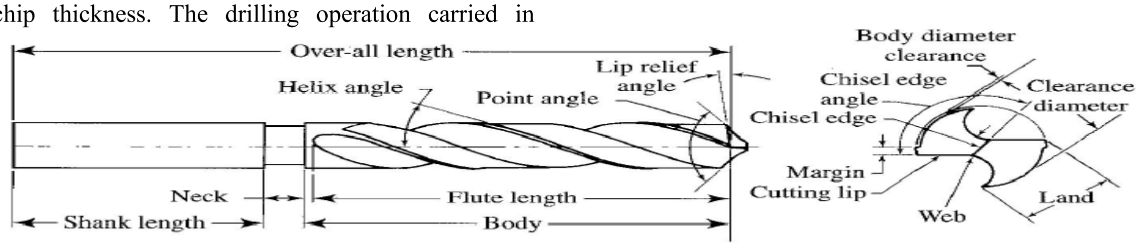


Fig.1: Configuration of a standard two-flute twist drill[14] and (b) an actual twist drill.

2. Workpiece and tool material:

M. Nouari et. al. carried test on an aluminum alloy (AA2024) with the chemical composition given in Table 1. Al 2024 is aircraft alloys that offer very high strength. [5] The tests were carried out with HSS and cemented tungsten carbide tools (coated and uncoated). A coating material called Hardlube ((Ti,Al)N+WC/C) was used for the cemented carbide drills. It is a multi-layer coating. The combination of hard/soft coating layers improves the chip flow by reducing the friction coefficient and the cutting forces. (Ti,Al)N is the hard layer with a hardness of 3300 HV and WC/C with a hardness of 1000 HV. To check the quality of coating scratch test carried out. The tests were carried out with HSS and cemented tungsten carbide tools (coated and uncoated). Other properties of tool shown in table 2. The holes were produced with a depth of 8 mm and a diameter of 6 mm in fig. 1.

Table-1 Chemical composition (wt %) of AA2024T351

Al	Cr	Cu	Fe	Mg	Mn	Si	Ti	Zn
93.5	Max 0.1	3.8-4.9	Max 0.5	1.2-1.8	0.3-0.9	Max 0.5	Max 0.15	Max 0.25

Results:

The economics of machining operations depends on useful life of cutting tool and its operating condition.

1. Hole diameter: The final shape of the hole is determined using a coordinate measuring machine. By keeping feed constant and changing cutting speed the graph is plotted for tool A, B, and C. Three cutting speeds (25, 65 and 165 m/min) and a constant feed rate of 0.04 mm/rev were selected for the experiments. The coating material constitutes a thermal barrier and limits the diffusion process. Diffusion is an activated thermal process, thus the formation of the adhesive layer at the tool–chip interface, and which is responsible of tool damage, can be avoided by using coating. Figure 3 shows that the graph plotted between diameter and number of holes to be drilled by tool B gives minimum hole deviation as compared to tool A and C.

2. Surface Roughness: It is necessary to find influence of cutting speed, coating on the surface roughness when drilled at certain depth. Surface roughness has been analyzed through the Ra factor. The trends show that drilling with the coated and uncoated carbide drills produced similar surface finishes while higher surface roughness values, hence poor surface finish, were recorded when drilling with HSS drills.[9] when cutting parameters increases, the surface roughness can be high (poor final shape of hole) because of drilling vibrations and the chatter which is an important factor for quality of produce holes.[5]

3. Wear measurement: Drill wear not only affects the surface roughness of the hole, but also influences the life of the drill bit. Wear in drill bit is characterized as flank wear,

chisel wear, corner wear and crater wear. Since wear on drill bit dictates the hole quality and tool life of the drill bit, online monitoring and prediction of drill wear is an important area of research. [2]

3.1 Statistical Analysis: To analyze tool wear statistical method and artificial neural network are used by C. Sanjay et. al. [3] The functional relationship between the response parameters, such as cutting speed, feed, time and thrust force for the cutting operation and the integrated independent variables which are given by:

$T_w = k_s^{\alpha} f^{\beta} F^{\gamma}_{c} T^{\partial}$ ---------------1)

where *T*w is the tool wear in mm, *s* the cutting speed in m/min, *f* the feed in mm/rev, *F*c the cutting force in N and *T* is the machining time in min.

The software used for statistical analysis is SPSS.

3.2 Artificial neural network: Back propagation neural networks were used for detection of drill wear. The neural network consisted of three layers input, hidden and output. Drill size, feed, spindle speed, torque, machining time and thrust force are given as inputs to the ANN and the flank wear was estimated.

An ANN that uses back propagation algorithms for modeling tool wear has been developed using machining process parameters as inputs and tool wear as output. Back propagation neural networks are typical feed forward networks. Making connections from the input layer to the output layer improves the learning efficiency. S.S. Panda et. al. conclude that [1] Back Propagation Neural Network can predict the wear more accurately as compared to Radial Basis Function Network. The error in prediction is more in RBFN compared to that in the case of BPNN, RBFN can learn the

pattern much faster compared to BPNN and could be used advantageously in online tool wear monitoring as shown in graph 1.

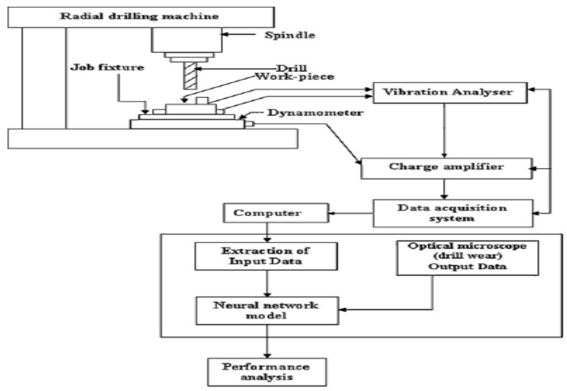


Fig.2. Schematic diagram of the experimental set-up

Table 2 The relevant properties of tools employed

	Tool A	Tool B	Tool C
Tool material	Carbide	Carbide	HSS
Tool reference	TF-Drill	TF-Drill	1055 (DIN 1897)
Coating	None	TiAlN+WC/C	None
Helix angle (°)	30	30	30
Point angle (°)	130	130	130

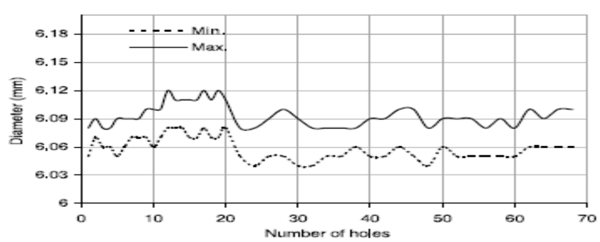
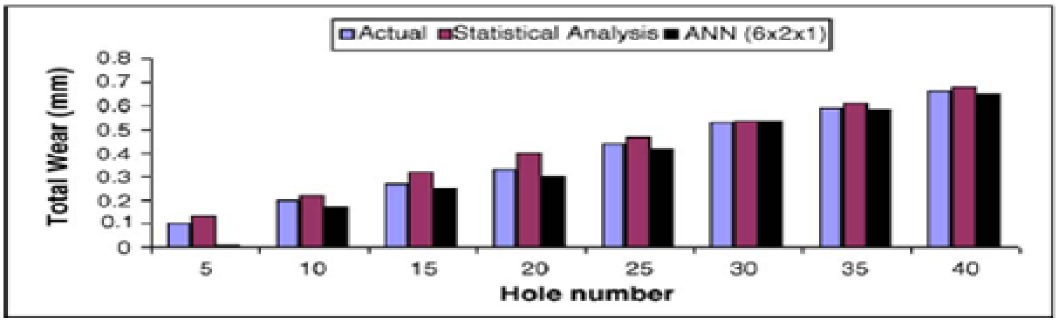


Fig. 3 Effect of the cutting speed on drilled holes after drilling with coated carbide drill B at a constant feed rate of 0.04 mm/rev 165 m/min.

Hole Number	5	10	15	20	25	30	35	40
Actual (mm)	0.1	0.2	0.27	0.33	0.44	0.53	0.59	0.66
Statist. Anlys. (mm)	0.13	0.22	0.32	0.4	0.47	0.54	0.61	0.68
ANN 6X2X1(mm)	0.008	0.17	0.25	0.3	0.42	0.54	0.58	0.65



Graph 1. (Tool wear) diameter 8 mm, speed 9.04 m/min and feed 0.095 mm/rev.

Result & Discussion:

Drilling is most common operation like turning. During operation it is mandatory to look towards drill life, surface roughness, cost of tool. To improve it different coating techniques are came forward. This study gives information that-

1) Substrate is also as important as coating thickness so hard and soft coating came forward like Hardlube ((Ti,Al)N+WC/C), (CrTiAlN), MoS_2 -Cr_x% coating.
2) A back propagation neural network is preferred instead of radial basis neural network for the prediction of tool wear. It is considered that tool wear depends on cutting speed, feed, thrust force and torque.
3) Substrate material properties also helpful to improve coating life.