A Review on PVD Coating Used in Piercing Operation for Improving Tool Life

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ABSTRACT

The main aim of paper is to predict influence of PVD coatings are applied on Piercing punches. In this study Piercing punches are coated with three different coatings of TiN, TiCN and CrN. Coatings plays important role to achieve the performance of piercing operation economically and to boost productivity. Mostly coatings are provided to overcome the tool wear, to increase hardness of tool and to reduce corrosion and oxidation, etc. Tool failure generally occurs due the more plastic deformation or fracture of tool.

The main aim of this research is to improve the piercing punch life. This study explores the actual industrial case study. Experimentations on piercing punch are carried with TiN, TiCN and CrN coatings by PVD technique. The results are validated with the help of FEA software.

Keyword: - *Coating, Piercing punch, wear, PVD ….*

1. INTRODUCTION

For conventional machining tool wear problem is unavoidable, PVD Coatings are the solution for this problem. i.e. cutting tools, plastic injection molding die, and tools for powder compaction etc. PVD coated tools, increases productivity viz. longer tool life, higher cycle frequencies, and less workpiece finishing, etc. also reduces manufacturing cost due to smoother surfaces, higher degree of metal deformation.

In cutting tools, it is necessary that tool must have hardness, high strength, abrasion resistant, as well as it must be chemically inert to prevent the chemical reaction between the newly generated surface of work piece and that of tool. Effectiveness of tool depends on fine grained free of binders and porosity. Naturally coating must be metallurgic to the substrate.

All these advantages can be reaching in metal cutting, sheet metal work, cold forming, pressure die casting and plastic processing. The application of PVD coating to improve tribological properties of tools (e.g. for metal forming and metal cutting) and machine element are constantly increasing.

Coated tools are finding wide acceptance in many manufacturing applications. Coated tools have two or three times the wear resistance than the best uncoated tools. Therefore, these tools have a broader range of applications. The advancement of coated tool technology has greatly attributed the advancement in manufacturing technology. There are basically two types of coating method named as chemical vapour deposition (CVD) and physical vapour deposition (PVD).

2. LITERATURE REVIEW

Aleksei tshinjana et al., (2012) describes in his paper that tool life can be prolonged by application of high performance alloy steels or ceramic-metal composites. Application of ceramic metal composites is limited by size of parts and the cost. For these tools from high alloy steel, particularly these with coatings, are used. Thin but hard single or multilayer coatings like TiN, TiCN, (Al, Ti) N are widely used to protect against wear and corrosion .use of thin coatings enables adhesion, abrasion and diffusion wear and friction to be reduced and heat resistance to be enhanced. Coatings processes like chemical vapour deposition and physical vapour deposition are increases tool life. The reason of PVD has become increasingly favorable over CVD when coating high alloy steel is the fact coating process occurs much lower deposition temperature (400°C -600°C).Other advantage of PVD Coating is ability to deposited much thinner films. A PVD technique is introduced in various machining and abrasion application. Thus study of this paper performance of tool steels, strengthened by PVD coatings, working in adhesion wear condition (metal cutting, forming and particularly in blanking).

R. Hambali et al., (2003) worked on tool wear and changed geometry of punch and die, clearance. The process of shearing and form of sheared surface was influenced by tool wear. He advised effect of dimensional accuracy and surface finish of product. It described phenomena related to wear and its impact on economy of industrial metal blanking processes. A quantitative approach to tool wear analysis would improve service life, leading to an important reduction in manufacturing costs.

Paper mentioned to provide a general finite element model allowing for numerical simulation of the punching process. The numerical results to verify the validity of proposed finite element model in describing the impact of tool wear.

Shanyong Zhang (1993) has described about metal processing technology and TiN Coated tool steel. Titanium Nitride is widely used in application of tool industries. The advantages of TiN coatings tool steel as noble appearance, excellent adhesion to substrate, chemical inert, and resistance to elevated temperature, a low coefficient of friction with workpiece materials which increases lubricity and results in excellent surface finish.to keep all condition equivalent, tool life improvement can be evaluated by comparing the increases no. of workpiece machined by TiN tool. The reason of coating on cutting tools in a production situation is increases tool life, to improve surface quality of the product and production rate increases. It was concluded that TiN Coating of tool steel was proven way of success in boosting production and curtailing cost. However PVD process more appropriate than CVD processes.

U.P. Singh et al., (1992) described in his journal deals with the study of 3-D finite-element models of various type of punching/blanking tools have been developed, these models analysis of the effects of variations in tool geometry on the punching/blanking force and on the punch deformation, a parameter highly relevant to the assessment of tool performance in terms of the accuracy of the manufactured components. The models create also for variation in the characteristics of the tool material, in that a highly wear-resistant tool is normally composed of carbide tips around its cutting profile. Analysis results by FE models are checked against design standards by American Society of Manufacturing Engineers (SME).

Melcot Jinikol (2009) Describes the important factor which controls the quantity of the product was tool life. For improving of the quantity of the product, one needs to maximize the tool life. There are lots of factors or parameter that will affect the life of tool. Main factor in the punching tool is wear that decreases the tool life. Tools often show adhesive and abrasive wear in the contact zone. In this study the parameter that can affect the wear like the shear angle of cutting tool, punching force, and also what are type of wear that occur in the punching tool. Resulting may design the new tool geometry that less wear occur, that will increase tool life.

Soumya Subramonian (2013) the journal about manufacturing process Blanking is a commonly used in the production of a variety of parts ranging from (a) Small electronic and electrical components like pins and connector parts to (b) high strength components and stainless steels. Depending on the application Sheets of 0.2–20 mm thickness and higher are blanked or punched. To improve the productivity of the process Irrespective of the type and thickness of the sheet material used, longer punch and die life is desired. Improving the punch and die life is especially useful in the blanking precision parts in large quantities. For high volume production, to increase die life in reduces (a) the changeover/ tool sharpening time, and (b) alignment time for punch and die and other tooling components. The various parameter of punch and die life and edge quality in blanking depend on (i)punch-die clearance (ii) punch and die corner radius portion (iii) punch and die materials and coating (iv) blank sheet material (v) stripper force and (vi) lubrication In this study, the conclusion of punch-die clearance is investigated further punch and die life to improve.

K. Bobzin et al., (2009) Describe about the PVD tool coatings materially gain importance for metal forming processes. In metal forming coated tools may enormously reduce tool and work piece wear, form capacities or formerly provided by lubricants and often toxic additives. As main properties, the coatings have to feature a very high adhesion to the substrate, a high hardness and adequate oxidation stability. To achive these requirements a nanolaminated TiHfN/CrN tool coating was developed using the arc ion plating technique. After the first step coating delivered the highest possible hardness in combination with the lowest possible Young's modulus. These properties, in combination with the ability to prevent the formation of cracks inside the coating structure, already led to affect the performances in several metal forming processes. As a second step, the development of an additional nano-structured CrN top layer which is used for the reduction of the friction coefficient by providing a lubrication supporting functional surface. To prove the developed coating's tribological performance application oriented tests were carried out, e.g. pin-on-disc, regarding the coating's behaviour in interaction with a biodegradable synthetic ester as lubricant.

N. Balasubramanyam et al., (2015) worked on very common industrial challenge in cutting tool industries was constantly facing of reducing cost of machined parts and at the same time improving the quality of the machined surface. Improving cutting tool materials these issues were generally addressed, to improving the geometry and surface characteristics of the cutting tools, optimizing machining parameters applying advanced coating. The contributes in reducing cost per machined parts through increasing productivity need for the use of newer cutting tool materials to combat hardness, wear situation has resulted in the occurrence surface coatings, and encompassing tool life. higher hardness, low friction at the chip tool contact, higher wear resistance, high hot hardness and high thermal and chemical stability these benefits of advanced coatings .To avoiding any built-up edge due to the reduced friction between the tool and work piece the machined surface quality with the coated cutter can also be developed. It is necessary to develop TiN, TIC, coatings on Tungsten carbide cutting tool Because of the abundant advantages of surface coatings and the requirement of industrial growth and condition, it was essential to do surface coating of TiN, TIC, on Tungsten Carbide cutting tool to give good mechanical and tribological properties which is Based on driving force.

B. Podgornika et al., (2011) in this paper to analysis the possibility of reducing lubrication and replacing expensive of tungsten carbide in blanking/piercing through introducing of hard tool coatings. Results show that hard PVD coatings can be successfully used in blanking/piercing applications, even on softer tool steels, thus leading to reduced friction and wear as well as to lower costs of the tool. On the other hand, even with the use of low friction coating (DLC) stamping force exceeds critical value under dry friction conditions and leads to tool failure. Therefore, at present oxidation and temperature resistant hard coatings can give improved wear resistance of stamping tools, but elimination of lubricants in blanking and piercing processes is still not feasible.

Y.B. Kumbhar et al., (2013) in this paper, tell about optimum process parameters for turning while semi hard machining of hardened EN31 alloy steel by using Taguchi approach. analysis of variance (ANOVA) were applied to study performance characteristics of machining parameters mostly included cutting speed, feed rate and depth of cut with consideration of surface finish and tool life. The conclusions publicized that the feed rate was the most leading factor on the surface roughness and tool life.

In physical vapor deposition (PVD) technique on tungsten carbide material advanced multilayer thin coatings deposited which used in order to increase wear resistance and decrease insert chipping.

The relative responses of Tool wear, cutting force, surface roughness and cutting power. Tool wear results in changes in tool geometry that affect cutting forces, cutting power, and surface finish. It is the main factor that defines the economics in metal cutting. A lower wear rate of tool means increased tool life, better surface finish, reduced tooling cost and lower cost of production.

In case of PVD TiAlN coating, at higher temperature the improvement in the cutting performance was due to the oxidation resistance of TiAlN properties. For the outstanding property of TiAlN High wear resistance even at high temperatures, a characteristic that makes this coating valid to cut abrasive work piece material such as aluminium silicon alloys, cast iron, and composite materials at high speeds.

4. CONCLUSIONS

From the literature review it is seen that, very less work has been done in field of Piercing Punches about its life. In sheet metal Industries punches are worn out, to improve its life coating is one of the method which applying on it.

U.P. Singh et al., Author emphasis on punching/blanking in variation of tool geometry, punching force and punch deformation. R. Hambali, Melcot Jinikol, Soumya Subramonian et al., Author emphasis on evaluation of tool wear in punching , tool wear affects tool life also work on punch and die clearance for affecting tool life.

Aleksei tshinjana et al., Shanyong Zhang, K. Bobzin et al., Author significance on wear performance of PVD Coating tool, Tin coated affecting on tool steel, PVD Coating on metal forming tool inn which studied TiHfN/CrN Coating.

N. Balasubramanyam et al., B. Podgornika et al, Y.B. Kumbhar et al., and Author emphasis on PVD coating on cutting tools and CVD on tungsten carbide, Application of hard coating for blanking and piercing tool also optimization of PVD coated on EN31 alloy steel in dry conditions.

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