Automation & Concrete Investigation of Drilling Parameters and Drilling Machines

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Abstract— Cutting parameters were evaluated and optimized based on multiple performance characteristics including tool wear and size error of drilled hole. Taguchi's L27, 3-level, 4-factor orthogonal array was used for the tests. It is shown that generally abrasive wear and built up edge (BUE) formation were seen in the tool wear, and the corner wear was also of major importance. Flank wear of the cutting tool was found to be mostly dependent upon particle mass fraction, followed by feed rate, drill hardness and spindle speed, respectively. Among the tools used, TiAlN coated carbide drills showed the best performance with regard to the tool wear as well as hole size. Grey relational analysis indicated that drill material was the more influential parameter than feed rate and spindle speed. The results revealed that optimal combination of the drilling parameters could be used to obtain both minimum tool wear and diametric error. The aim of this study was to investigate the wear mechanisms as well as the hole diameter accuracy, and to introduce the Taguchi method in determining optimum drilling conditions on the tool's flank wear.

Key words: Spindle, Carbide Drills, Taguchi Method, Optimal, Diametric Error, Abrasive Wear, Flank Wear

I. INTRODUCTION

Automation or automatic control, is the use of various for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching in telephone networks, steering and stabilization of ships, aircraft and other applications with minimal or reduced human intervention. Some processes have been completely automated. The biggest benefit of automation is that it saves labor, however, it is also used to save energy and materials and to improve quality, accuracy and precision. The term automation, inspired by the earlier word automatic was not widely used before 1947, when General Motors established the automation department. It was during this time that industry was rapidly adopting feedback controller which were introduced in the 1930Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, and electronic and computers, usually in combination. Complicated systems, such as modern factories, airplanes and ships typically use all these combined techniques.

The main objective of Automation Control System used in the industry are:

- To increase productivity
- To improve quality of the product
- Control production cost

Due to their high specific strength, superior wear resistance, lower thermal expansion and lightweight, metal matrix composites (MMCs) are used as substitute for conventional materials in some engineering applications such as aerospace, electronics, automotive, medical and military industries. They are preferred in wide variety of applications such as bearings, pistons, connecting rods, automobile brake rotors, sliding electrical contacts, turbo charger impellers, space structures. Matrix, reinforcement and nature of the interface affect the properties of these composites, and reinforcement materials are generally used in the form of particles, whiskers or fibers in different fractions ranging from few percentage up to 60% Selecting and combining of suitable reinforcement and matrix qualification are key factors in their fabrication. Various matrix materials such as Al, Ti and Mg are used, while mostly used reinforcements are SiC, Al2O3 and B4C. In addition, several production methods such as powder metallurgy (PM) and stir casting are used to produce MMCs. The major disadvantages of the latter method are agglomeration of the ceramic reinforcements, formation of porous structure and poor wetting between the particles and matrices On the other hand, PM has some important advantages such as simplicity, cheap processing, homogenous distribution of the reinforcement particles and high quality mechanical properties. However, the machines ability of these composites is difficult because of hard abrasive reinforcement particles causing rapid tool wear, thus leading to labor losses, high tool cost, size error, poor surface roughness and less tool life. Therefore, the cutting tool may be used more effectively by knowing the wear mechanisms dependent on the cutting parameters and machining conditions.

II. REVIEW OF LITERATURE

The tool geometry of a drill is more complicated than other cutting tools. Because of this complexity, majority of the researches on the tool wear in drilling are based on the investigation of experimental data. The common wear types in drilling are, in general, crater and flank wear. Owing to the high tool-chip interface temperature, crater wear caused mostly by diffusion occurs on the rake surface where chip flows through the cutting tool. However, flank wear (VB) is usually considered as criterion of tool life or a significant guide to assess the tool performance in machining. More than that, two abrasive wear mechanisms namely two-body and three-body are dominant when machining MMCs.

Currently, although there are a number of studies on MMCs drilling, limited studies exist on the drilling of B4C reinforced composites regarding the cutting tool performance and drilled hole size accuracy. Until now, mostly Al_2O_3 and SiC particles, whose hardness were HV 2100−2300 (Vickers Hardness) and HV 2700−3500, respectively, were used as reinforcement elements. Past studies on the drilling of MMCs stated that the main wear type is flank wear, and abrasive and adhesive wear mechanisms are prevalent in the cutting tool. Abrasive hard particles create micro grooves on the tool's cutting edge and these grooves get larger with increasing cutting speeds, resulting in built-up edge (BUE) formation by filling these micro grooves with the squeezed work piece material.

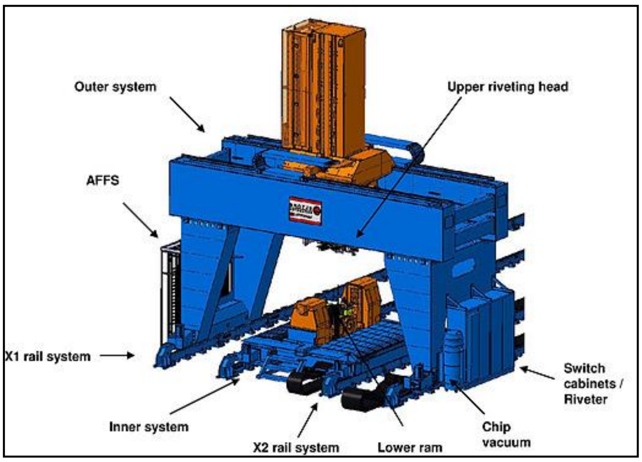

Fig. 1: Drilling Machine

Additionally, there has been an increase on BUE formation as the hole number increases. Some earlier researchers argued that the BUE layer plays an important role in the protection of tool-chip surface Nevertheless, other researchers claimed that the continuous slipping of the BUE particles through the tool-chip interface might cause the tool wear From the point of view of cooling, through-tool cooling improves the tool wear and reduces the BUE formation in comparison with the conventional cooling and dry cutting. Furthermore, the influence of the tool's corner and flank wear on the dimensional accuracy of the hole was analyzed. Grey relational analysis was applied to investigate how the cutting parameters affect the quality targets of the tool wear and hole dimensional accuracy. The analysis of variance (ANOVA) was conducted for the factors, and their contribution rates were determined. This work will be a good guide for selecting optimal machining parameters for the tool flank wear and diametral error of the drilled hole.

III. Composite Material Production

Composite materials consisting of 10% B4C, 15% B4C and 25% B4C were produced by PM method in prismatic dimensions of 50 mm×70 mm×12 mm. This method was similar to the fabrication route used by previous researchers. The powder with average sizes of 8µm for Zn, 15µm for Cu and 30µm for B4C and Al were used for composite productions. For this purpose, metal powders of Al, B4C, 3.5% Cu, 5% Zn and 2.5% Mg were weighed with Symmetry EC4000 electronic balance having 0.1 g accuracy and then uniformly mixed in a mixing bowl. The ball milling method, having 36 ZrO2 balls, was used for mixing of the powders. After packing the mixture with Al foil, it was cold pressed into the mold under 25 MPa. Later, in order to fill the voids between metal and ceramic powders with Zn, the furnace temperature was kept at a constant temperature of 540 °C and composite specimens were fabricated by liquid phase sintering for 0.5 h at the temperature. Finally, the mold was kept inside the furnace until the furnace temperature reached 250 °C and then placed in the open air to complete the cooling. Hardness and tensile tests were also performed on the produced composites also performed on the produced composites.

IV. Types of Coordinates System

A. *Cartesian coordinate system*

A Cartesian coordinate system is a coordinate system that specifies each point uniquely in a plane by a pair of numerical coordinates, which are the signed distances from the point to two fixed perpendicular directed lines, measured in the same unit of length

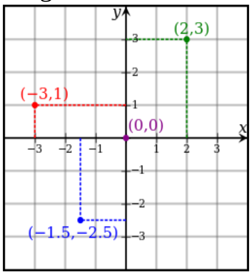

Fig. 2: Cartesian coordinate

B. *Polar coordinates System*

In mathematics, the polar coordinate system is a two-dimensional coordinate system in which each point on a plane is determined by a distance from a reference point and an angle from a reference direction.

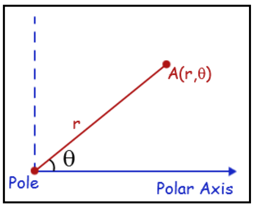

Fig. 3: Polar Coordinates

V. Design Criteria

Motion to drill bit is provided by sliding pairs or sliders. A base is to be design over which the slider (A) will be placed. Slider A will translate along an axis (say X-axis). another slider B will be placed over slider A which will translate in Y axis as shown at the end of slider B at the end of slider B portable drilling machine is to be fixed and motion to it will be provided along Z axis. The measurement of the hole size is of significant importance for a variety of applications. For evaluating the dimensional accuracy, hole diameters were measured with the ABERLINK-AXIOM II 965 CNC CMM machine having 0.1µm accuracy. Two measurements were made at 5 mm distance from the hole entrance and hole-exits for each hole. Total error of the hole diameters was used.

VI. Advantages & Disadvantages

The main advantages of automation are:

- Increased throughput or productivity.
- Improved quality or increased predictability of quality.
- Improved robustness (consistency), of processes or product.
- Increased consistency of output.

The main disadvantages of automation are:

1) Security Threats/Vulnerability: An automated system may have a limited level of intelligence, and is therefore more susceptible to committing errors outside of its immediate scope of knowledge (e.g., it is typically unable to apply the rules of simple logic to general propositions).

2) Unpredictable/excessive development costs: The research and development cost of automating a process may exceed the cost saved by the automation itself.

VII. Future Plans

In this section of our project writing of first step and in this we are feeling that in this section there is a large future scope in future as well as in present too. The thing is that we don't know how to explore and we need to learn that element only. Drilling experiments of MMCs were carried out to study the effects of machining parameters such as particle mass fraction, drill material, spindle speed and feed rate on the tool wear and dimensional accuracy of the drilled hole. Machining parameters were optimized based on the grey relational analysis. According to the experimental results, mostly abrasive wear and BUE were observed in the cutting tools, and the tool wear increased with particle mass fraction and decreased with feed rate.

1) To determine method of providing translation motion to sliders.
2) Taking variable dimension of sliders we will be calculating reaction force, normal force or any other force and bending moments.
3) Material of base and slider will be decided on the basis of calculated load, force and moment.

VIII. Conclusion

- We have learned coordinate system and its type.
- We have also studied about Cartesian and polar coordinate to know which one is best appropriate for automation.
- After studying about coordinate we come to know polar coordinate best appropriate for automation.
- Rather than this we also studied about types of pair, joint, and types of constrained motion so that we should have appropriate knowledge for automation.
- We have also learned designing of drilling machine.
- And we shall use sliding pairs on this project.

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