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Effect of preheating on machinability of titanium alloy

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Highlights

- Tool life is based on cutting speed with room temperature.
- In preheated zone end milling significantly increase the tool life.
- Preheating condition increase the optimum cutting speed and metal removal rate.
- Preheating method is the alternative for machine the difficult materials.

Abstract

This works presents preheating method to improve the machinability of titanium compound. With the effect of warming work piece (pre-heating) using induction coil (heating) system, speed, feed and depth were investigated in the midst of end milling process on a vertical machining center (VC450-Spinner). Additionally, WC-Co PCD inserts were positioned 25 mm apart on the mill (R390-025B25-11M/R390-170408E-NLH13A) and the effects of preheating on tool life, smoothness of the surface, force of cut, vibration/chatter, irregularities, and chips/tool morphology were examined. The execution of uncoated WC-Co was greatly implemented (directionally around multiple times appeared differently compared to room temperature machining), the tool life estimations were essentially higher than those of PCD under room temperature machining. Preheating machining reduces vibration and chatter resulting in increased cutting force and extended tool life. In addition, chip-device contact length is extended and chip serrations are formed reducing equipment wear. As a result of the experimentation, it was found that the execution of uncoated WC-Co was greatly enhanced in the preheated method. Moreover, tool life estimations with PCD at room temperature are significantly improved.

Introduction

Titanium is HCP crystal structure of unalloyed which is also denoted as α phase in room temperature but which transforms to BCC (β) phase at the 883 °C. The transformation of Titanium from α phase to β phase strappingly influences the presence of alloying elements [1], [2], [3], [4]. But this change of phase α-β transformation at room temperature happed to the vanadium, niobium and molybdenum promotes the formation of the β phase in some of the compositions of both α and β phases will coexist [5], [6], [7], [8]. The phases are presented into α -β materials are serene of both α and β phases but in a small proportion of β- phase, they contain low concentrations of β stabilizers [9], [10], [11], [12]. The transformation of phases improves the mechanical properties and machining characteristics which is similar to the α materials except the diversity of change of microstructures which is near of the α- alloys. so that, α-β phase material selected for experimental work (etchant HF 10%; HNO 35% and H_2O85%) as shown in Fig. 1 (a).

Cutting tool life and characteristics are the most important aspect of the any manufacturing industry, any machining operation to improve the tool life a limited cutting feed and speed to be maintained in most of the cases this can be achieved by the manufacturers. Unless the productivity and profit are lost by the manufacturers, to improve the tool life carbide coated high-speed steel (HSS) tools were used. The coating process increases the 15 to 20% of the tooling cost than the uncoated tools this increasing cost to be compensated by increased life of the tool and in most of the steel tools are generally coated by physical vapor deposition (PVD) processes [13], [14], [15]. Some cases the diamond tipped tools were used based on the requirement with appropriate justification of cost. Ceramic material i.e. metal binder materials were processed by cermet's which improves the productivity of the manufacturing firm of the Electo-Discharge Machining (EDM) and Electro-Chemical Machining (ECM).

- Carbide or Sintered Carbides
- Polycrystalline diamond

Titanium is one of the strongest materials which possess the good material characteristics lightweight, corrosion-resistant metal. The usage and importance of the titanium is increased day by day. Titanium has 210 MPa of yield strength after the heat treatment which can be elevated 1300 MPa, the higher degree of strength can be improved be heat-treated alloy steels. A good mechanical property can be getting at 535 °C temperatures in other hand the titanium alloys possess the high cost, fabrication difficulties with high energy content [16], [17], [18], [19]. The ASTM specification B-265 is the generally grouped alloys of the heat treatment for the micro structural features. The Table 1 shows details of the α, β and α-β titanium alloys at room temperature. HCP alpha phase or the BCC beta phase stabilize the alloying elements, the heat treatment improves the microstructural characteristics of the material properties [20], [21], [22].

Section snippets

Literature review and research gap

Dry machining of titanium combinations is incredibly troublesome as a result of the temperature close to the near, which ought to be controlled to ensure the surface uprightness of work-piece and to stay away from tool wear. Hot machining found endless application in the collecting of planning portions in the late 20th century, a century after it was first introduced. The norm behind hot machining is the augmentation of the qualification in hardness of the cutting instrument and workpiece,

Methodology

The modeling of tool life, Ra and resultant force in end-mill with uncoated WC-Co & PCD inserts under preheated conditions. Similar to experiments under room temperature conditions, in order to get overlapping information between two cutting tools, the lowest cutting speed (80 m/min) for experiments with PCD were selected lower than the highest speed (160 m/min) for experiments with uncoated WC-Co inserts. Furthermore, the axial doc kept constant 1 mm, the reason behind selecting constant axial

Result and discussion

The significant operations are conducted in that depth of cut is to be fixed 0.6, 1.0 and 1.6 mm with these parameters to run the tool (uncoated WC-Co insert) minimum speed is 485 rpm and the maximum speed 2550 rpm. Also fix the depth of cut 0.60, 1.10, 1.65 and 2.10 mm with the parameters to run the tool (PCD insert) minimum speed 1300 rpm and the maximum speed 3000 rpm as shown in Table 4. In room temperature machining to increase the cutting parameters (cutting speed, axial depth of cut,

Conclusion

Finally it was conclude that the tool life is depends on cutting speed related parameter with room temperature as well as preheating conditions for end milling Ti6Al4V, with help of uncoated WC-Co and PCD inserts are given best results that are cutting speed increase to increase temperature, in preheated zone end milling was increase the tool life in the cases of both the cutting tools. Mostly feed factors are effect to surface roughness under both conditions (Room temperature/preheated

Declaration of Competing Interest

No funding is received by the authors for performing this research work

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