國立雲林科技大學機械工程系

碩士論文

Department of Mechanical Engineering
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Master Thesis

微奈米氣泡結合八軸噴氣軸承輔助法於細孔放電加工之研究

Micro-Nano Bubbles Combined with Eight-Axis Air Jet Bearing Assisted Method for Fine Hole Electrical Discharge Machining

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中華民國 108 年 12 月

December 2019

摘要

放電加工的加工液，在工具電極和工件之間（數微米～數百微米）極小間隙中帶走加工屑和冷卻作用，其流動更新的速率是影響加工特性非常重要的關鍵。此現象在細孔放電加工高深徑比（數十～數百）微小孔的時候更為明顯。加工所使用的中空電極管需要透過超高壓馬達(250 bar)來克服流體與管壁的摩擦力才能輸出加工液，而這也是導致馬達的耗能及加工效率差的原因。

水的粘度（0.8mPa-s）約是空氣的（18μPa-s）44.5 倍，將氣體混入液體形成微奈米氣泡加工液，可有效降低流道與流體之間的摩擦阻力。本研究運用微奈米氣泡去離子水加工液，進行細孔放電加工的測試，經實驗證明能夠大幅提高放電加工效率、精度及降低馬達泵浦運轉的負載等諸多優點。

現有的細孔放電加工機的眼模（功能為引導且穩定旋轉中的電極）有 2 個缺點；其一、在組裝電極尺寸越來越小的時候容易受損及磨耗。其二、在更換不同尺寸的電極時，眼模也需同時更換。

本研究提出八軸噴氣機構，利用氣體軸承的概念來支撐電極管，配合不同尺寸的電極管，可以得到無磨損、通用性等優點，達到與眼模相同的功能。初步透過實驗證實在電極管尺寸為 1.0 mm 時，此機構能夠達到引導且穩定電極的加工效果。

關鍵字：微奈米氣泡、細孔放電加工、氣體軸承

Abstract

Machining fluids in EDM, flowing in the micron-scale gap between the electrode and work piece, remove the debris and cool down the work piece. Therefore, the renewal rate of the fluid is a key parameter for the influence of the machining properties, especially in fine hole EDM process. Normally, hollow electrode is used in fine hole EDM and high-pressurized motors (250 Bar) are required to overcome the friction inside the electrode, resulting in high energy consumption and poor machining efficiency.

The viscosity of water (0.8 mPa-s) is around 44.5 times of air (18μPa-s). The machining fluid with micro/nano bubbles can effectively reduce the friction inside the electrode. In this study, we propose to utilize DI water with micro/nano bubbles in fine hole EDM process. We demonstrate the micro/nano bubbles can greatly improve the machining efficiency, accuracy, and the power consumption of pressurized motors.

The guider use in fine hole EDM processes has two disadvantages: (1) it is easier to be damaged or abrasive with the reduction of electrode size. (2) it should be changed when the size of electrode is different. In this study, we also propose air-pressure nozzles to replace the guider. Eight nozzles are used to support the hollow electrode in fine hole EDM process. The proposed supporting mechanism has no wear at all and fit to different sizes of electrodes. We demonstrate that the mechanism can steadily guide and support the electrode with a diameter of at least 1 mm.

Keywords*:* micro-nano bubbles, fine hole discharge machining, air bearing