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Experimental investigations on nano powder mixed Micro-Wire EDM process of inconel-718 alloy

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ABSTRACT

This research investigates the effect of graphite nano powder suspended in dielectric medium of Micro-Wire EDM process of inconel alloy. The main influencing parameters such as voltage, capacitance, and powder concentrations were considered. The machining characteristics of material removal rate (MRR), kerf width (KW) and surface roughness (SR) were investigated. Twenty seven experiments were carried out based on full factorial design by varying voltage, capacitance and powder concentration each at three levels. Data were analyzed using Design Expert software. It is from the experimental investigations show that the presence of graphite nano powder in the dielectric can improve the topography and roughness of the machined surface significantly especially R_a values reduced from 0.830 μm to 0.418 μm in addition to higher material removal rate of 0.0055 mm^3/min. The higher material removal rate as well as good surface quality was achieved at graphite nano powder concentration of 0.5 g/l, capacitance of 0.01 μF and Voltage of 100 V.

1. Introduction

Micro-Wire EDM is a key technology for machining of hard alloys and tempered steel for production of precision micro tooling such as micro injection and micro punching for micro mechanical, optical and electronic devices. Micro-Wire EDM process is an effective machining technique used for the production of micro electrodes, micro mould, micro holes, micro cutting, micro injection needle, micro air turbine, micro gear and production of micro milling tools.

Micro-Wire EDM is a variant of micro-EDM process, which uses electrical discharges between the work piece and micro wire electrode, resulting in melting and vaporization of very small amount work material. Debris particles are flushed out from the sparking area by the dielectric fluid. In Micro-Wire EDM a line of spark occurs on the contact surface of the both electrodes and work piece, it has higher efficiency than the micro-EDM, suitable for machining of any conductive material irrespective of its hardness.

The high temperature and high strength capability of inconel 718 super alloy makes ideal application for aerospace and power generation industries especially gas turbines, rocket motors and spacecrafts as well as in nuclear reactors, pumps and tooling [1].

Micro machining like micro moulds, micro holes etc. on these materials could be very difficult due to high tool wear and huge expenses involved. Hence certain nontraditional micromachining techniques are considered in order to meet the present demand for high accuracy. Machining of micro parts/feature can be easily performed by Micro-Wire EDM process using micro-wire tool (diameter range from 0.03 mm to 0.3 mm) with higher machining rate and superior surface finish [2].

Modern manufacturing industries, particularly tool, die and mould making industries have high surface finish requirements. Additives mixed EDM are able to produce mirror-like finish on the work pieces. Surface finish depends on the suitable range of input parameters, proper combination of additives, and selection of workpiece materials [3]. Anil Kumar [4] presented a wide-ranging history about the mechanism of AEDM process, and reviewed research literature in the area of AEDM. AEDM plays a major role in attractive the process capabilities of EDM process. Addition of powder in electric medium lowers dielectric strength and this leads to increased starting of sparking process and stability of the process. Machining performance and surface characteristics significantly influenced by powder type, size, shape, concentration and thermal properties of powder.

Chow [5] successfully applied additive mixed electric discharge machining (AEDM) process for micro slitting of titanium alloy (Ti-6Al-4V) by adding silicon carbide (SiC) and aluminium powder

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