

Experimental investigation and multi-objective optimization of micro-wire electrical discharge machining of a titanium alloy using Jaya algorithm

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ABSTRACT

Micro-wire electrical discharge machining (Micro-WEDM) process exhibits superior precision and greater relative accuracy for the efficient machining of difficult-to-machine materials. The micro-slit cutting operation using WEDM process has been experimentally investigated for the objective of analysing the average kerf-loss and responses pertaining to the economic viability of the process viz. average cutting rate and volumetric material removal rate (MRR_v). The experiments are performed using a Tungsten wire of diameter 70 μm on titanium grade 5 alloy (Ti-6Al-4V). Three different controllable process variables (input parameters) associated with the Resistance-Capacitance (RC) based power generator namely discharge energy, wire feed-rate and wire travelling speed are varied to demonstrate their impacts on typical responses such as average kerf-loss, average cutting rate and MRR_v . The experimental analysis revealed a close relationship that cutting rate bears with discharge energy, wire feed-rate and efficient flushing of molten liquid as well as fine debris particles. An advanced multi-objective optimization technique popularly known as Multi Objective-Jaya (MO-Jaya) algorithm has been adopted for the simultaneous optimization of average kerf-loss, average cutting rate and volumetric material removal rate. The best set of input parameters have been selected to suggest the most optimum responses for micro wire-cutting operations.

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Eksperimentalna raziskava in večkriterijska optimizacija obdelave z mikrožično erozijo titanove zlitine z algoritmom Jaya

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POVZETEK

Proces obdelave z mikrožično erozijo (Micro-WEDM) ima vrhunsko natančnost in večjo relativno natančnost za učinkovito obdelavo materialov, ki se težko obdelujejo. Postopek rezanja mikroroze z WEDM je bil eksperimentalno raziskan, da bi analizirali povprečno izgubo v vplivni coni reza in odzive, ki se nanašajo na ekonomsko upravičenost postopka kot sta povprečna hitrost rezanja in stopnja odstranjevanja materiala (MRR_v). Poskusi so izvedeni z volframovo žico s premerom 70 μm na zlitini titana razreda 5 (Ti-6Al-4V). Variirane so tri različne procesne spremenljivke (vhodni parametri), povezane z generatorjem moči na osnovi upornosti in kapacitivnosti (RC), in sicer razelektritvena energija, podajalna hitrost žice in pomična hitrost žice, da raziščemo njihov vpliv na značilne odzive, kot so povprečna izguba v vplivni coni reza, povprečna hitrost rezanja in MRR_v . Eksperimentalna analiza je pokazala tesno povezanost hitrosti rezanja z razelektritveno energijo, podajalno hitrostjo žice in učinkovitim izpiranjem staljene tekočine ter drobnih delcev. Za sočasno optimizacijo povprečne izgube v vplivni coni reza, povprečne hitrosti rezanja in hitrosti odstranjevanja materiala je bil uporabljen napredni pristop večkriterijske optimizacije, imenovan tudi večkriterijski-Jaya (MO-Jaya) algoritem. Izbrana je bila najboljša kombinacija vhodnih parametrov, ki omogoča optimalne rezultate pri obdelavi z mikrožično erozijo.

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PODATKI O ČLANKU

Ključne besede:

Obdelava z mikrožično erozijo (Micro-WEDM);
Večkriterijska optimizacija;
Titanove zlitine;
Izguba v vplivni coni reza;
Stopnja rezanja;
Stopnja volumetričnega odstranjevanja materiala;
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