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Development and Investigation of Hybrid Electric Discharge Machining Electrode Process

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Abstract

Hybrid Electric Discharge Machining Electrode (HEDME) process is developed by comprising the features of Electric Discharge Machining (EDM) and traditional grinding which occurs alternatively in place of their simultaneous effect as Electric Discharge Grinding (EDG) process. This paper reports the experimental study of HEDME during machining of High Carbon Alloy Steel for material removal rate (MRR), tool wear (TW) and surface roughness (SR). The experiments were carried out on an indigenously developed HEDME attachment on Sparkonix EDM. The effects of main machining parameters such as type of tool, current and machining time have been studied. The effect of the machining on the workpiece surface machined by HEDME has been optimized using Taguchi L_9 orthogonal array and results are reported. Experimental study shows that the TW is found to be the least with third design of the electrode and it decrease with the decreasing value of current, also surface finish increases with decrease in current. Moreover, the third design of electrode gives the lowest SR and highest MRR.

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*Keywords:*HEDME; EDM; Grinding; MRR; TW; Surface Roughness.

1. Introduction

In today's fast growing technological world, machining of hard-to-machine metals have been a challenge for the manufacturing firms. The ergonomic value of the finished product has always been the market need and to meet it, continuous improvement is mandatory. The refinement of quality of product largely depends on efficiency and productivity of the process involved. Various machining processes have been evolved as the product design and

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Nomenclature

EDG	Electric discharge grinding
EDM	Electric discharge machining
GA	Genetic algorithm
HEDME	Hybrid electric discharge machining electrode
HMP	Hybrid machining processes
MRR	Metal removal rate
SR	Surface roughness
TWR	Tool wear rate

demand changed. To meet the growing demands, manufacturing industries have by passed the unconventional machining processes and found their solution in the hybrid machining processes (HMPs). These processes are combination of one or more machining processes to incorporate the advantages of both. The development of such processes have revolutionised the machining of very complex geometries on difficult-to-machine metals without compromising the surface finish. These unconventional machining processes have helped achieve high precision and high dimensional accuracy even for the most complex profile at a reasonable cost. The HMPs can be grouped into collaborative and cooperative process based on their involvement in material removal process. They usually club unconventional machining process with the abrasive grinding process in order to enhance the performance and efficiency of the process.

2. Literature Review

Today's industries aim at meeting the everyday challenges faced by them. This includes the most prominent factor of machining of difficult-to-machine metals along with the need of automation, high dimensional accuracy and precision. To accomplish the aims of the market new researches and experiments are being conducted all-round the globe. Quality requirements of desired product should be met effectively and economically by the machining process. Hence, to make the process compatible with changing product demand and design, it would be worthy to increase the efficiency of the process [Shan (2005)]. The principle of EDM is analogous to the principle of EDG. Both the processes are being extensively researched to explore the new findings. Machining of the difficult to machine electrical conductive advance engineering materials is accomplished by the EDM process, an efficient and effective alternative without compromising its performance due to the workpiece mechanical properties [Jain (2004), Benedict (1987)]. Similarly grinding is used to machine advance engineering materials but its use is limited due to generation of surface cracks on ground surface and high specific energy [Kopac et al. (2006), Hegeman et al. (2002)]. Like grinding, EDM restricts its applicability due to the generation of residual stresses, low machining rate and formation of recast layer. Researchers initially substituted the stationary electrode with rotating disk wheel made of electrically conductive materials. This developed process is known as electrical discharge grinding (EDG) [Jain (2004), Benedict (1987)]. [Wei et al. (1995)] studied EDDG process under the name of Abrasive Electro-Discharge Grinding (AEDG) and tested its performance during machining of tungsten carbide and poly crystalline diamond through a comparison between the hybrid and constituent processes concluding MRR to be significantly improved along with high quality surface. [Kozak (2002)] researched the machining of the polycrystalline diamond (PCD), aluminium silicon carbide (Al/SiC) composite and polycrystalline cubic boron nitride (PCBN) with copper bonded diamond wheel in cut-off grinding mode. [Koshy et al. (1996, 1997)] investigated the mechanism of material removal and effect of process parameters of EDDG process during machining high speed steel and cemented carbide