Chapter 8

Optimization of Process Parameters for Electro-Chemical Machining of EN19: Using Particle Swarm Optimization

Divya Zindani
National Institute of Technology Silchar, India

Nadeem Faisal
Birla Institute of Technology, India

Kaushik Kumar
Birla Institute of Technology, India

ABSTRACT

Electrochemical machining (ECM) is a non-conventional machining process that is used for machining of hard-to-machine materials. The ECM process is widely used for the machining of metal matrix composites. However, it is very essential to select optimum values of input process parameters to maximize the machining performance. However, the optimization of the output process parameters and hence the machining performance is a difficult task. In this chapter an attempt has been made to carry out single and multiple optimization of the material removal rate (MRR) and the surface roughness (SR) for the ECM process of EN19 using the particle swarm optimization (PSO) technique. The input parameter considered for the optimization are electrolyte concentration (%), voltage (V), feed rate (mm/min), and inter-electrode gap (mm). The optimum value of MRR and SR as found using the PSO algorithm are 0.1847 cm³/min and 25.0612, respectively.
INTRODUCTION

The traditional processes such as grinding, milling, turning, drilling etc., remove material by mechanical abrasion, micro chipping or chip formation. However due to the following reasons the traditional processes are not economical and even possible (Kalpakjian, 1984):

- Hardness is very high i.e., above 400 HB.
- Material is too brittle
- The machining forces are too high for the delicate and slender workpiece specimen.
- The complexity of the part to be machined.
- The residual stresses in the machined component which is not at all acceptable.

The above disadvantages have led to the development of other material removal mechanisms such as chemical, thermal, electrochemical and other hybrid mechanisms. These material removal mechanisms have therefore resulted in machining processes referred to as non-traditional machining processes. Owing to the advantages offered by the non-traditional machining processes, these are available for a wide range of industrial applications. The source of energy used differ from process to process and therefore can be categorised accordingly: thermal and electrothermal processes such as laser beam machining, ion beam machining, electric discharge machining etc., chemical and electrochemical processes such as electrochemical machining, electrochemical honing etc., mechanical processes for instance ultrasonic machining water jet machining etc. and hybrid processes as for instance abrasive electrical discharge machining etc.

Amongst the different processes, electrochemical machining (ECM) process is one of the most promising methods and is the prime focus in the present study. The electrolysis process is the working principle of the ECM process (Rajurkar et al., 1999)the laws of which were formulated by Faraday in 183. In the ECM process tool and the workpiece are respectively the cathode and the anode. A high current density ranging 10-200 A/cm² results on application of a constant potential difference across the two electrodes. A suitable electrolytic solution is used such that the shape of the cathodic tool remains unchanged. The electrolytic solution is pumped at rates ranging 3-60 m/s and serves to remove the unwanted machining waste and minimize the effects arising due to electrical heating and generation of gas at the electrodes. The gap width along the electrode length reaches a steady value as the cathodic tool approaches the workpiece. Under these conditions the shape of the cathodic tool is produced as a mirror image on the anodic workpiece.

The ECM process possess a number of advantages such as the capability to handle a large number of materials which are not limited by their mechanical properties but by their electrochemical properties. The difficult to machine materials and high strength alloys are machined by the ECM process with higher material removal rates. Further, the ECM process can easily machine and shape the fragile parts. The advantages such as the machining of the 3D curved surfaces free from striation marks, burrs and stress, no tool wear makes the ECM process a widely accepted machining processes for a number of applications. A wide range of sophisticated parts such as rifle bores, turbine blades, micro components etc., are being manufactured using the ECM process.

However the ECM process suffers from a number of limitations such as higher power consumption, high cost on initial investment and large floor space. The problem is further aggravated with the issues of toxicity and the corrosion from the etchants. Further the changes taking place at the inter electrode
14 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the product's webpage: www.igi-global.com/chapter/optimization-of-process-parameters-for-electro-chemical-machining-of-en19/216696?camid=4v1


Recommend this product to your librarian: www.igi-global.com/e-resources/library-recommendation/?id=102

Related Content

Benefits of Probabilistic Soil-Foundation-Structure Interaction Analysis

Numerical Modeling of Buried Pipe under Wheel Loads Using FLAC 3D

Application of Neurocomputing to Parametric Identification Using Dynamic Responses

Principles and Advantages of Microwave-Assisted Methods for the Synthesis of Nanomaterials for Water Purification