Chapter 44
Optimization Through Nature-Inspired Soft-Computing and Algorithm on ECG Process

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ABSTRACT

In the present research work selection of significant machining parameters depending on nature-inspired algorithm is prepared, during machining alumina-aluminum interpenetrating phase composites through electrochemical grinding process. Here during experimentation control parameters like electrolyte concentration (C), voltage (V), depth of cut (D) and electrolyte flow rate (F) are considered. The response data are initially trained and tested applying Artificial Neural Network. The paradoxical responses like higher material removal rate (MRR), lower surface roughness (Ra), lower overcut (OC) and lower cutting force (Fc) are accomplished individually by employing Cuckoo Search Algorithm. A multi response optimization for all the response parameters is compiled primarily by using Genetic algorithm. Finally, in order to achieve a single set of parametric combination for all the outputs simultaneously fuzzy based Grey Relational Analysis technique is adopted. These nature-driven soft computing techniques corroborates well during the parametric optimization of ECG process.

1. INTRODUCTION

Our modern lifestyle is improving day by day because of the swift improvements and developments in modern technology. To overcome our daily life problems, it is important to achieve more efficient solution. Mathematical dynamics of the related solution based on nature has a remarkable impact. Nature servers various possible approach to think about solution and helps to develop efficient scientific methods.

DOI: 10.4018/978-1-7998-0414-7.ch044

Eventually, the connection between science and nature has made several possibilities for new research work. There is countless nature inspired techniques which can be utilize for the modern intelligent solution approach. As these nature-inspired techniques are very much effective on forming efficient algorithm, they are quite popular amongst modern Artificial Intelligence research. This is also remarkable that these techniques can easily use with other associated intelligent techniques in order to form new hybrid techniques. Mostly, correlative characteristics by the swarm in the nature had given researcher to develop various types of algorithm methods inspired from swarm such as bat, bee, firefly, cuckoo etc. Then again it is similarly possible to generate new nature-inspired techniques based on the theory of evolution. It is also remarkable that efforts are always given for optimizing the pre-deigned techniques to accomplish a more possible ideal solution to the real life problems. Genetic Algorithm is one such nature-inspired technique which is developed based on the theory of survival of the fittest by Darwin.

The ever-increasing precision machining requirements ultimately call for optimized machining process to sustain in the competition in the global market. To sustain in this competitive business industries are introducing several modifications by altering the traditional manufacturing process to non-traditional manufacturing process. Electrochemical Grinding (ECG) is one such non-traditional machining process which is a collective process of electrochemical dissolution and mechanical grinding. This method is generally applied for generating complex shape with high surface finish of high strength electro conductive material, low machinability alloy with high brittleness. In ECG process a small gap between conductive cathode grinding wheel and anode work piece is filled with flowing electrolyte through which dielectric current passes. The main factors affecting ECG process are Electrolyte concentration (C), Machining Voltage (V), Depth of cut (D), Flow rate of electrolyte (F), type of the abrasive wheel, physical properties of the work piece, relative speed in between tool and work piece, particle size on the abrasive wheel etc. As the machining process is mainly governed by the electrochemical dissolution of the work piece material, the generating surface is free from burr and residual stress as a result there is almost no chance of rejecting a material due to the surface cracks. Apparently, ECG process generate finished surface, therefore there is no need of time consuming additional finishing operations.

Some review of the past research works is presented here. Zhang et al. (2015) employed ECG process on Inconel 718. To elongate the wheel life, the brazed diamond wheel is utilised as a tool in place of the electrodeposited diamond wheel. Experiments showed that the tool durability has been improved significantly from 15 hours to 50 hours while a brazed diamond wheel is employed to replace an electrodeposited diamond wheel. Roy et al. (2007) investigated an experimental study, organized by statistical procedure, is made to calculate the effect of the major effecting parameter 'voltage' on the roughness of P-20 grade cemented carbide. The roughness data are investigated for different voltages. Lyubimov et al. (1998) are presented of diamond consumption in electrochemical in comparison with the routine grinding process. Initiation, development and the mutual correlation of various components of the diamond deterioration - adhesion, abrasion, diffusion, chemical wear and cracking at the electrochemical grinding - are discussed. Maksoud and Brooks (1995) investigates the electrochemical grinding process when used to machine metal-bonded diamond composite wheels. These wheels are utilise as form tools to grind ceramics. Operational parameters such as feed rate, electrolyte flow and current density, are investigated. The optimum operating conditions are evaluated. A comparison with conventional grinding methods is made also. Ilhan et al. (1992) has studied to optimize electrochemical grinding (ECG) process responses simultaneously by an off-line multi response optimization methodology. The responses considered as objectives are side and bottom overcuts, total metal removal rate, surface finish, spindle load and cutting wheel wear. It is shown in this paper that the multi-objective optimization technique can be