Multi Response Optimization of WEDM Process on OHNS Die Steel Using ANN, SA and GA

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ABSTRACT

In the present research work Oil Hardened Naturally Shrinking (OHNS) work-material which is commonly used in plastic industries is considered for machining by WEDM process. Four different control parameters are deliberated to study the effect on the responses like material removal rate, overcut and surface roughness. To reduce the total number of experiment, L27 orthogonal array is used. Analysis of Variance is applied to attain the significant process parameters affecting the responses. The effect of the responses with the control parameters is plotted through S/N ratio graphs. To find the effect of the parameters on the responses and thereby developing a mathematical model regression analysis is done. The response data are examined using artificial neural network. Single objective parametric combination for each response is obtained using simulated annealing. A multi response optimization for the responses is done initially by using genetic algorithm and finally by applying Grey relational analysis.

KEYWORDS
ANN, ANOVA, GA, OA, OHNS Die Steel, Regression Analysis, SA, S/N Ratio, WEDM

1. INTRODUCTION

Wire Electrical Discharge Machining (WEDM) is a non-conventional, thermo-electric machining process which has an important role in high-precision and high-performance manufacturing industries due to it is capability of accurate and efficient machining of parts with varying hardness or complex shapes and sharp edges of the work piece (El-Hofy, 2005). In WEMD material removal take place by controlled erosion of the electrically conducting material (Mishra, 1997). The process is based on removing the material from the work piece by a series of discrete sparks between an anode work piece which is immersed in a dielectric liquid medium and continuously feeding cathode wire through the work piece control by a microprocessor (Ghosh and Mallik, 1991). This electric discharge melts and vaporizes small amounts of the work material, and the removed material is flushed away by the flowing dielectric liquid. As the tool wire and the work piece does not make direct contact during machining, so there is no machining stress, chatter and vibration. Therefore, this process can be used in machining of alloys having low machinability and high temperature strength resistance.

In order to achieve high quality, high process safety, minimal manufacturing cost and lowest possible machining time the manufacturing process parameters have to choose in the optimized way. The major factors influencing WEDM process are Pulse On Time (Ton), Pulse Off Time (Toff), Wire Feed, Wire Tension, Servo Voltage, Open Voltage, Peak Current and Dielectric Pressure (Ikram, et al. 2013). The photograph of WEDM setup is illustrated in Figure 1.
A brief literature review of the past research work is presented here. Bobbili et al. (2013) presents the influence of machining parameters on surface roughness (Ra) and material removal rate (MRR) of high strength armor steel using WEDM. Tests was carried out with six process parameters: pulse-on time, pulse-off time, wire feed, flushing pressure, spark voltage, and wire tension. Zhang et al. (2014) studied on the effects of high temperature and massive electrical discharges on tool steel (SKD11) during medium-speed WEDM and found the optimal parameters on MRR and 3D surface quality by using integrated response surface methodology along with Non-Dominated Sorting Genetic Algorithm-II (NSGA-II). Liao et al. (2014) has studied on the association amid machining parameters and machining characteristic using a neural network on two kinds of materials with distinctive specific discharge energy values, i.e., higher and lower, respectively and genetic algorithm was employed to find the optimal combination of machining parameters for different materials. Patil and Brahmankar (2010) has investigated on the effect of thermo-physical properties of the work piece, pulse-on-time and average gap voltage on MRR in WEDM process for silicon carbide particulate reinforced aluminum matrix composites work piece and find out significant role of coefficient of thermal expansion in this process. Ramakrishna and Karunamoorthy (2006) has reviewed the effect of pulse-on-time, wire tension, delay time, wire feed, and ignition current intensity on Ra, MRR and wire wear ratio (WWR) using Taguchi’s methodology and Multi response S/N ratio. ANOVA is used to find the importance of the machining parameters for multi performance characteristic. Chen et al. (2014) has explored on the cause of geometric inaccuracy in corner cutting in WEDM and some optimized control factor combinations are sought by generalized non-linear regression model. Mahapatra and Patnaik (2007) has deliberate on the control factors and responses like MRR, surface finish and cutting width and
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