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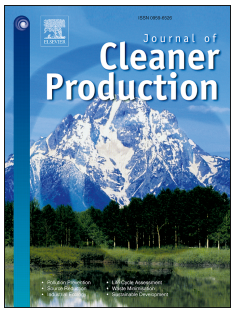

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Ibrahem Maher, Ahmed A.D. Sarhan, Mohsen Marani Barzani, M. Hamdi

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Increasing the productivity of the wire-cut electrical discharge machine associated with sustainable production

Ibrahem Maher [a], **Ahmed A. D. Sarhan** [b,*], **Mohsen Marani Barzani** [c], **M. Hamdi** [d]

[a,b,c,d] *Centre of Advanced Manufacturing and Material Processing, Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia*

[a] *Department of Mechanical Engineering, Faculty of Engineering, Kafrelsheikh University, Kafrelsheikh 33516, Egypt*

[b] *Department of Mechanical Engineering, Faculty of Engineering, Assiut University, Assiut 71516, Egypt*

* *Corresponding Author / E-mail: ah_sarhan@yahoo.com, TEL: +603-7967-4593, FAX: +603-7967-5330*

Abstract:

Wire-cut electric discharge machining is a nontraditional technique by which the required profile is acquired using sparks energy. Concerning Wire-cut electric discharge machining, high cutting rates and precision machining is necessary to improve productivity and achieve high quality of machined workpieces. In this research work, an experimental investigation was introduced to achieve higher productivity of the wire electrode associated with sustainable production in terms of product quality and less heat-affected zone. For this purpose, the effects of machining parameters including peak current, pulse on time and wire preloading were investigated using adaptive neuro-fuzzy inference system along with the Taguchi method. From this study, the optimal setting of machining parameters to achieve higher productivity and sustainability was identified. Moreover, Neuro-fuzzy modelling was successfully used to build an empirical model for the selection of machining parameters to achieve higher productivity at highest possible surface quality and minimum cost for sustainable production.

Keywords: Sustainable production, Energy consumption, Wire-cut EDM, ANFIS, Taguchi

1. Introduction

Wire-cut Electric Discharge Machining (Wire-cut EDM) is an advanced machining process for machining complicated shapes of hard conductive materials (Sommer and Sommer, 2013). Wire-cut EDM is usually used when low residual stresses are required, because it does not entail high cutting forces for material removal. Wire-cut EDM can machine any electrically conductive materials regardless of the hardness, from common materials such as copper, aluminum, tool steel, and graphite, to unusual modern alloys including wafer silicon, Inconel, titanium, carbide, polycrystalline diamond compacts. Besides, Wire-cut EDM is also used to machine modern composite materials such as conductive ceramics (Ho et al., 2004; Maher et al., 2015c). In Wire-cut EDM, the workpiece is machined with a series of electrical sparks that are produced between the workpiece and the wire electrode. The wire electrode discharges high frequency pulses of alternating or direct current to the workpiece through a very small spark gap with a nonconductive dielectric fluid. Many sparks can be easily seen instantaneously at the cutting zone because sparks happen more than one hundred thousand times per second (El-Hofy, 2005). Cutting rate and surface