ICIAS2012 1569562241

Erosion Rate Model Comparison of Electrical Discharge Machining Process

Azli Yahya[1], Trias Andromeda[1,2], Muhammad Arif Abdul Rahim[1], Ameruddin Baharom[1]
[1] Universiti Teknologi Malaysia/Faculty of Electrical Engineering, Johor 81310, Malaysia
[2] Diponegoro University/Electrical Engineering, Semarang 50275, Indonesia
Email: azli@fke.utm.my, trias1972@gmail.com, arif@fke.utm.my, amer@fke.utm.my

Abstract—**This paper reports a comparison studies between two erosion rate model and experimental results of an Electrical Discharge Machining (EDM) process for high gap current. Two erosion rate models are Dimensional Analysis (DA) model and Artificial Neural Network (ANN) model that have been summarized from the previous author's publication. The data analysis is based on a copper electrode and steel workpiece materials. The result indicated that the ANN model provides better accuracy than the DA model when compared to the experimental results.**

Index Terms—**Electrical Discharge Machining, Dimensional Analysis, Artificial Neural Network, MRR**

I. INTRODUCTION

Electrical Discharge Machining (EDM) is a process of material removal using an accurately controlled electrical discharge (spark) through a small gap (approximately 10 to 50 microns) filled with dielectric fluid between an electrode and a workpiece. The technique allows machining high-strength and wear-resistance materials such as high-strength alloys, polycrystalline diamond and ceramic (ultra-hard conductive material) since the hardness of the workpiece has no effect on the process. Unlike the traditional cutting and grinding processes, which depends on the force generated by a harder tool to remove the softer material workpiece, the EDM process is free from contact force and chatter vibration. Furthermore, EDM permits the machining to be done even after the hardening process. The EDM process has been used in high precision machining of metals, and to date, there are several different types of EDM systems that were developed for a particular industrial application. EDM applications ranging from drilling micro-holes that are smaller than human hair to machining large automotive dies, aerospace and surgical components[1]. Some studies in machining advanced materials, mirror surface finish using powder additives, ultrasonic-assisted EDM, control and automation have been reported by[2]. Other researchers conducted various investigations in process performance [3,4] while the study of optimal selection of process parameters has increase the production rate by reducing the machining time [5,6]. However, the optimum selection of machining parameters for the best process performance is still uncertain since EDM process is a complex and stochastic process. Mathematical model for electrode and workpiece has been developed by [7] based on the boundary condition of the plasma formed between the cathode (workpiece) and the anode (electrode). However, these models are presented in a complex relationship between the material and the plasma that based on the thermophysical properties of the plasma applied over the temperature range from solid to liquid melt. Furthermore, these models are not conveniently feasible for use in the more simplified Matlab/Simulink simulation study. The following sub-chapters summarize the development of Dimensional Analysis (DA) model and Artificial Neural Network (ANN) model for erosion rate (material removal rate) that have been developed by the authors [8-10].

II. MODEL OF EDM PROCESS

The EDM process is a process of removing material in a complex combination of electrical, thermal and mechanical effects. Fig. 1 illustrates the EDM process where the profile of voltage and current in the spark gap is shown in Fig. 1(c).

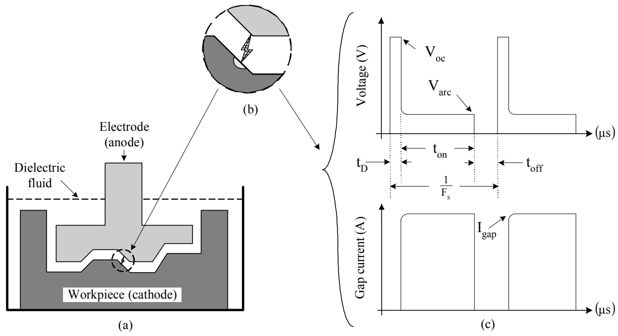

Figure 1. EDM Process

At First, a high voltage V_{oc} is applied during the delay time t_D. During this time, a high electric field is formed between the electrode and workpiece (at the position of least resistance). At the end of the delay time, the insulation effect of the dielectric fluid breaks down, current begins to flow whilst the voltage falls, signaling the start of the discharge phase. The spark is thus formed and machining takes place during the ON-Time t_{ON} with a machining current I_{Gap} and a voltage across the gap V_{arc}. At the end of the on-time, the flow of current is interrupted and the desired insulating electric properties of the dielectric fluid are recovered during the OFF-time t_{OFF}. A high gap current, I_{Gap} of EDM process for the experimental is