CHAPTER 1

INTRODUCTION

1.1 Project Background

Wire Electrical Discharge Machining (WEDM) is a very specialized method of machining using thermal to machine parts accurately for parts of various hardness and complexity. This non-traditional machining method is based on the conventional EDM sparking process and the material removal technique is a non-contact. The WEDM is considered to be a non-traditional material removal process widely used to manufacture parts with complex shapes and profiles. WEDM has become an economical and popular choice of machining to fulfill customer needs for a quick production cycle time and reducing production cost. Due to this, many experiments have been carried out to find methodologies to optimize the process parameters of the WEDM machine.

WEDM is used to machine a wide variety of miniature and micro-parts from metals, alloys, sintered materials, cemented carbides, ceramics and silicon. This tremendous achievement in WEDM technology has been achieved by many researchers from some of the world leading institutions and research centres, but still cannot cope with the new materials introduced to the market.

Wire Electrical Discharge Machining (WEDM) is a rather simple process with wire limited to copper and brass functioning as electrode. WEDM is a thermo electrical process in which material is eroded from work piece by a series of discrete sparks between the work piece and the wire electrode (tool) separated by a thin film of dielectric fluid that is continuously fed to the machining zone to flush away eroded particles. The movement of wire is controlled numerically to achieve the desired three-dimensional shape and accuracy of the work piece. The degree of accuracy of work piece dimensions obtainable and the fine surface finishes make WEDM particularly valuable for applications involving manufacture of stamping dies, extrusion dies and prototype parts. Without WEDM, the fabrication of precision work pieces requires many hours of manual grinding and polishing.

WEDM is now widely applied in different areas of the industry. For example, WEDM is now used in the machining of various materials used in modern tooling applications. The feasibility of using cylindrical WEDM for dressing a rotating metal bond diamond wheel used for precision form grinding of ceramics has also been studied (Norliana et al, 2007). The WEDM process has also evolved as one of the most promising alternatives for the machining of advanced ceramics. Puertas et al (2003) provided a literature survey on the EDM of advanced ceramics which has been commonly machined by diamond grinding and lapping. WEDM is also considered as an effective and economical tool in the machining of modern composite material.

Various WEDM research is currently going on in the industry. They can be divided into two major areas namely WEDM process optimization together with WEDM process monitoring and control.

1.2 Research Statement

The most effective machining strategy is to be able to determine and identify the different factors affecting the WEDM process and looking for ways of obtaining the machining condition and performance. The experience of the WEDM machine operator also plays a role in the contribution towards achieving the desired output. WEDM manufacturers claimed that their machine will offer superior performance. However, this is achieved through their lab test and not in the real manufacturing environment.

DF2 tool steel is a general purpose oil-hardening tool steel suitable for a wide variety of cold work applications. Its application can be found in the area of the making of tools, gauges, measuring tools, turning-centres, guide bushes, small gear wheels, pistons, and so many other applications. Broad base of DF2 knowledge is now in existence due to its wide acceptance in the industry. However, the parameter setting on WEDM of DF2 is still lacking. The data provided by manufacturers is helpful but inadequate.

DF2 is assigned to be machined with WEDM in this project with the focus to study the parameters setting for an optimum machining.

1.3 Research Objectives

The objectives of the research are:

i. To determine the optimal level of machining parameters that will influence the machining responses (Surface Roughness and Material Removal Rate) during the machining of the DF2 tool steel using WEDM.

ii. To establish mathematical models for surface roughness (R_a) and material removal rate (MRR) of the machining of DF2 using WEDM.

1.4 Scope of Study

This research covered:

i. A wire electrical discharge machine (WEDM) from NEEM Technology (Taiwan) was used.

ii. The DF2 (ASSAB) cold work tool steel was used as the work piece material.

iii. Zinc coated brass wire of diameter 0.25mm was used as electrode.

iv. Parameters to be studied are: *Open Circuit Voltage (OV)*, *Pulse Duration (ON)*, *Wire Speed (WF)* and *Flushing Pressure (WA).*

v. Response variables studied were surface roughness (R_a) and material removal rate (MRR).

vi. The design of experiment (DOE) and analysis of variance (ANOVA) were processed using the Minitab 15.1.1.0 software.