UNIVERSITI TEKNOLOGI MARA

CUTTING QUALITY INVESTIGATION OF Ti-6Al-4V USING WIRE ELECTRIC DISCHARGE MACHINE

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ABSTRACT

Over the years, the machining of titanium alloy has grabbed the attention of many manufacturer sector and scientist research community from around the world. Titanium alloy is popular due to its excellent characteristics of high strength to weight ratio and highly corrosion resistant compared to other existed materials. However, titanium alloy has such drawback that limits its utilization, including complexity of the extraction process, difficult in melting and cause problems during fabrication and machining process. Nevertheless, wire electric discharge machining (WEDM) process has been proven to be a versatile and commercially preferred machining process by utilizing titanium alloy raw work piece material. Therefore, numerous research works have been established globally to improve the machinability of titanium alloy in WEDM process. Successes in the machining of titanium alloy can be achieved when the right cutting conditions are applied during the machining operation. This research reviews the machinability of titanium alloy Ti-6AI-4V, highlighting the effect of Wire EDM cutting parameter on machining responses. The mathematical model of the machining response (kerf width and surface roughness) using Response Surface Methodology (RSM) developed. Following an extensive literature survey on the key aspects relating to WEDM process, including operational advantages and challenges, machine tools, equipment, cutting mechanisms. Five main phases of experimental work were undertaken to evaluate the machinability of WEDM of Ti-6AI-4V. The results showed that the average percentage error between the predicted and experimental value was less than 5%. In addition, the developed prediction models can well describe the variation of kerf width and surface roughness response for future analysis. The characteristics of the surface integrity of the WEDM sample and it observed that micro-crack was detected on the machined surface. However, there was a formation of white layer formed on each sample analyzed. It was also found that when peak current increases, the white layer thickness also increases. As a result, an enhancement of the on the principles of machining titanium alloys, the properties that impair their machinability and performance of different machining parameters, that enhance the machining of titanium alloys were able to be comprehended. Thus, will lead to efficient and economical machining of titanium-base super alloys.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Until the discovery of titanium for the first time in 1791, demand for titanium is now is so high, especially in the aviation industry, medical equipment, and military. However, the need of titanium alloy for military industry began when the Cold War between Russia and USA took place. The race involves increasing high requirements, especially in the manufacture of airframe and turbine engine of jet fighters. Also titanium alloy need so much for missiles construction. In the field of commercial aerospace, competition in the titanium requirements have also increased tremendously, especially in the competition for the design of new wide body models and low in fuel consumption. The most significant competition is among the largest manufacturers from Boeing and Airbus.

The rivalry between the two giant commercial aircraft manufacturers in terms of efficiency in the use of fuel, causing these two manufacturers to find an answer to the new methods in machining technology and find a ways to use new alloy materials. For forty years, the production of aluminium in the aviation industry has dominated for the overall metal requirement. The advantage of this aluminium is lightweight, inexpensive and not easily rust. Therefore, aluminium dominates about 70% of the overall weight of the airplane. Aluminium can be seen anywhere on the airplane as in the cockpit, seats, airframe, landing gear and jet engine turbine.

In the era of Industry Revolution 4.0, the usage of aluminium has been replaced with the latest advanced materials such as fibre-reinforced polymers (CFRP). The era of Industry Revolution 4.0 through the use of metal 3D printers, manufacturing of aircraft parts was coming together with titanium inside and cover outside with CFRP. Jet turbine engine manufacturers such as General Electric (GE), Pratt and Whitney, Rolls Royce and Northrop Grumman have been so much pressured by customers to supply a new jet engine that reduced the weight, withstand more to higher temperatures and saving in fuel consumption.