Review On Zinc Coated Brass Electrode Wires on The Surface of WEDM Cut Component

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Abstract: The requirement for high-performance, lightweight space propulsion systems has prompted rapid investigation of refractory metals that are capable of withstanding high stress levels at elevated temperatures, and also have a low ductile-to-brittle transition temperature for withstanding high frequency vibrations at cryogenic temperatures. The metals which demonstrate these requirements are the Niobium based alloys. C-103 niobium was selected to satisfy initial design requirements because of its excellent fabricability. C-103 niobium is considered the most "forgiveable" Niobium alloy from the standpoint of welding and spinning. Hardware which has had as much as 600" of TIG weldments formed after welding and coating has withstood a 2T bend at -196°C (-320°F) after the unit had completed its duty cycle. Although it is considered a first-generation alloy, succeeding Nb-1 Zr, C-103 niobium was developed to replace the weaker alloys, but retain the desirable formability characteristics and welding properties. This Niobium-Hafnium-Titanium alloy satisfies most rocket engine applications for temperatures up to 1482°C (2700°F) because of superior mechanical properties at all temperatures.

Key Words: —*Nb-Hf Alloys, TIG Weldment, 2T bend.*

I. Introduction

The history of electrical discharge machining techniques is very long when it was found by an English Scientist. EDM was not fully used until 1943 when its use by Russian scientist was done on erosive effect of EDM for machining purpose. When it was first observed by Joseph Priestly in the year 1770, EDM was very not very precise. Commercially developed in the mid of 70s, wire EDM found to be a workable technique that gave the shape of present metal processing industry, in the mid of 80s.The EDM techniques were transferred to a machine tool. This migration made EDM more widely available and appealing over traditional machining processes. Going with the advancement of mechanical industry, the requests for combination materials having high hardness, strength and effect resistance are expanding. All things taken in account; these materials are hard to machine by conventional machining strategies.

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Hence, non-conventional machining strategies including electrochemical, ultrasonic and electrical discharge machining are used to machine these hard to machine materials. WEDM uses a thin (generally 0.25mm) wire as a cathode which changes electrical sparks into thermal energy which is in turn used for cutting materials. Using this process, machining can be performed on materials, not taking into account of their hardness or toughness. Generally, aviation materials, tool and die steels (alloy steels) and ceramics which are conductive can be machined. Also, WEDM is fit for delivering a fine, exact, erosion and wear safe surface. WEDM is considered as a novel selection of the ordinary EDM process, which utilizes a terminal to instate the sparking procedure. Be that as it may, WEDM uses a constantly travelling wire terminal made of thin copper, tungsten or brass of diameter across 0.05-0.30 mm, which is fit for accomplishing little corner radii. The wire is kept in strain utilizing a mechanical tensioning gadget decreasing the propensity of delivering imprecise parts. Amid the WEDM procedure, the material erodes in front of the wire and there is no immediate contact between the work piece and the wire, wiping out mechanical stress while machining

II. Literature Survey

The analysis [1] introduce that the study the effect of wear parameters like applied load, sliding distance and sliding speed on the dry sliding wear of Niobium C-103 refractory alloy. Wear tests of Niobium C-103 alloy are carried out on pin on disc wear testing machine by varying the sliding speed, sliding distance and applied load. The effect of these parameters on wear rate has been determined by using ANOVA analysis, which shows that wear rate is mainly affected by load and then sliding speed and sliding distance. The experimental results were used to construct artificial neural network. Two layer and three-layer feed forward network with back propagation technique was used for modeling of ANN.

In this paper [2], focus of this work was to study the effect of cutting parameters – speed, feed and depth of cut on the machinability of Niobium C-103 under dry machining condition using response surface methodology (RSM). In present study various machinability models were developed. This machinability models defined a functional relationship between cutting variables and response (Cutting Temperature). Cutting levels for experimentation was selected based on the cutting insert manufacturer recommendations. The analysis shows that Cutting speed is the most evident factor for cutting temperature.

This paper [3] introduced on advancing the wire electrical discharge machine (WEDM) process parameters for the normal surface roughness (Ra) acquired in machining of VANADIS 4e (Powder metallurgical cold worked Tool steel). The Machining analyses were performed at WEDM machine utilizing 0.25 mm coated brass wire as electrode material on p/m cold worked tool steel. Taguchi L27 orthogonal array (OA) was utilized to outline of trial. Ideal methodology parameters were resolved utilizing the signal- to- noise (S/N) proportion which was computed for Ra as per "smaller-the-better" approach. The methodology parameters of WEDM procedure were pulse on time, pulse off time, servo voltage, peak current, wire tension and water pressure. The impacts of the methodology parameters on surface roughness were assessed by the examination of change (ANOVA). The surface roughness increases with increase in pulse on time and peak current and decreases with pulse of time, spark gap set voltage and wire tension.

The Paper [4] mentioned the degradation mechanisms relevant to hypersonic environments have been investigated for silicide-coated niobium alloys. To assess the suitability of silicide coatings for possible leading edge, scramjet combustor, and vehicle acreage applications, tests were conducted over a range of oxygen and water vapor partial pressures. X-ray diffraction was used to characterize the composition of oxide phases. Chemical compositions of both the coatings and resulting oxides have been examined using energy dispersive x-ray analysis. Partial pressures of oxygen and water vapor have been found to influence the oxide composition, which may include silica, chromia, iron niobate, and chromium niobate phases. The formation of volatile oxide and hydroxide species also affects oxidation behavior and coating performance. Thermodynamic models of oxidation and volatilization are used to interpret experimental results.

The paper [5] shows refractory metals that exhibit significant oxygen solubility can harden and/or embrittle at low oxygen pressures without formation of a significant oxide layer. However past studies have shown that the addition of alloying elements, especially those that have a strong affinity for oxygen (e.g., Ti, Zr, Hf) significantly alter morphology of oxides and thus, the mechanical properties at a given oxygen concentration. Niobium based alloys used commercially generally contains very high reactive additions such as Hf, Zr and Ti. Although niobium oxides have very large negative free energy of formation, the free energies of Hf, Zr, Ti oxides are even more negative. Thus, one can expect that niobium alloy containing these solutes should internally oxidize during heat treatment at vacuum levels of1×10^{-3} Pa. Because mechanical properties can be influenced markedly by formation of precipitates, there is practical interest in the internal oxidation of niobium-based alloys. The objective of the present work is to study the effect of internal oxidation on the microstructure and mechanical properties of C-103 alloy. Tensile specimens and test coupons of alloy containing different levels of oxygen (100–2500 ppm) were characterized with respect to microstructure and mechanical properties.

The analysis [6] introduce the attempt has been made to analyze the machining conditions for Material Removal Rate (MRR), Surface Roughness (SR), cutting width (kerf) and dimensional deviation during WEDM of Inconel 718 using DoE such as Taguchi methodology, L8 Orthogonal Array. The experimental analysis is carried out using Minitab 16 software and it was observed that pulse-on-time is the most influential factor for all the response variables such as MRR, SR, Kerf and dimensional deviation at 95 % confidence level, with contributions of 54.32 %, 58.42 %, 83.21 % and 36.11 % respectively. Along with this, peak current was observed to be next significant parameter for kerf and dimensional deviation whereas for MRR and SR servo voltage was observed to be the next significant parameter. Dimensional deviation is affected by increase in pulse on time, peak current, wire feed and spark gap set voltage. However, increasing pulse off time and wire tension found to be improving dimensional deviation.

III. Problem Statement

Surface roughness quantification was done by utilizing a portable stylus-type profilometer (Taylor Hobson, Surtronic-3+) as shown in figure. The profilometer was set to a cut-off length of 0.8mm and 4mm valuation length. The least count of the profilometer is 0.01 micron.

IV. Conclusion

In this study, the effect of process variables on response measures (SR) of S7 Niobium C 103 was investigated experimentally in WEDM. Also, a comparative study is carried out to know the effect of different electrode wires (brass wire and zinc coated brass wire) on the output values.

- Pulse on time (TON) is the most significant factor for surface roughness for machining with both brass wire and Zn coated brass wire with 71.01% and 64.05% contribution in mean.
- From SEM micrographs it is observed that surface Roughness with Zn coated brass wire is less compared to brass wire.
- Increase in discharge current and pulse duration causes a significant increase in discharge energy which in turn affects the SR by increasing spark diameter and the depth of discharge craters.
- At optimum levels for brass wire SR is obtained with 4.4% error and for Zn coated brass wire SR is obtained with 2.4%.
- Comparing both wires, Zn coated wire is giving more optimum results with lesser surface roughness at same levels of input parameters.

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