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Optimization And Analsys Of Cu-W Tool Edm Process By Using Composite Materials

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ABSTRACT: The Conventional machining processes were developed to machine the different kind of reinforcements. But they lost their competitive edge to non-conventional machining because of poor surface finish, high tool wear rate and high tooling cost. To Increasing the weight ratio of Copper in has high tensile strength, electrical conductivity and low resistance. The machinability of copper composites with respect to cost effective non-conventional machining like EDM have yet been studied. Powder metallurgy has been an effective method of producing copper composite material. This performance analysis and optimizing the machining parameters of mild steel and Inconel 625 for EDM process. Tool can be made up of copper and tungsten material. So increase production rate, reduced machining cost, tool wear rate (TWR) is decreased and improved surface finish of the composite materials.

Keywords :-EDM; Powder additives; machining; optimization.

I. INTRODUCTION

Composites have already proven their worth as weight-saving materials however the current challenge is to make than cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. a group of processes that remove excess material by various techniques involving mechanical, thermal, electrical or chemical energy or combinations of these energies but do not use a sharp cutting tools as it needs to be used for traditional manufacturing processes.Electric discharge machining process is carried out in presence of dielectric fluid which creates path for discharge. When potential difference is created across the two surfaces of die electric fluid, it gets ionized. An electric spark/discharge is generated across the two terminals. The potential difference is developed by a pulsating direct current power supply connected across the two terminals. One of the terminals is positive terminal given to work piece and tool is made negative terminal. Two third of the total heat generated is generated at positive terminal so work piece is generally given positive polarity. The discharge develops at the location where two terminals are very close. So tool helps in focusing the discharge or intensity of generated heat at the point of metal removal. Application of focused heat raises the temperature of work piece locally at a point, this way two metals is melted and evaporated. Electrical-discharge machining (EDM) is an unconventional, non-contact machining process where metal removal is based on thermal principles. In this process, the material removal mechanism uses the electrical energy and turns it into thermal energy through a series of discrete electrical discharges occurring between the electrode and work piece immersed in an insulating dielectric fluid. The thermal energy generates a channel of plasma between the cathodes and anode at a temperature in the range of 8000–12,000 ◦C, initializing a substantial amount of heating and melting of material at the surface of each pole. When the direct current supply is turned off, the plasma channel breaks down. This causes a sudden reduction in the temperature allowing the circulating dielectric fluid to implore the plasma channel and flush the molten material from the pole surfaces in the form of microscopic debris.T.Tamura,et.al.(2013) Development of on-the-machine surface modification technology in EDM As a method of processing cemented carbide, sinking electrical discharge machining (EDM) is generally used. However, typical surface defects, such as cracks, micro craters and recast layer, lead to a decreased surface integrity, probably resulting in a short tool life. The surface defects are eliminated using a sinking electrical discharge machine by introducing surface integrity machining for EDM (SIME) after applying finishing EDM. As a result, the surface defects generated by EDM could completely eliminated by incorporating SIME into EDM. Rajeev Kumar, et.al. (2012) research is oriented on newer aspects of EDM in the field of analysis and optimization. The mathematical models have been developed to predict material removal rate and surface finish while machining AISID2 tool steel at different machining conditions.Chinmaya P.Mohanty,et.al.(2012) Thermal-structural Analysis of Electrical Discharge Machining Process thermal-structural model is presented to analyze the process parameters and their effect on three important responses such as material removal rate, tool wear rate and residual stresses on work piece in electrical discharge machining (EDM).process. Regression analysis is conducted to develop equations relating responses with process parameters. Finally, non-dominated sorting genetic algorithm is used to obtain pareto optimal solution for multi Objective optimization.Jambeswar Sahu,et.al.(2012) A DEA approach for optimization of multiple responses in Electrical Discharge Machining of AISI D2 steel optimization methodology for the selection of best process parameters in multi-response situation. Experiments have been conducted on a die-sinking electric discharge machine under different conditions of process parameters. A response surface methodology (RSM) is adopted to establish effect of various process parameters such as discharge current (Ip), like material removal rate (MRR), tool wear rate (TWR), surface roughness (Ra) and circularity (r1/r2) of machined component.S.L.Soo, et.al.(2010) The effect of wire electrical discharge machining on the fatigue life of Ti-6Al-2Sn-4Zr-6Mo aerospace alloy experimental data for the fatigue behavior of aero engine alloy Ti-6Al-2Sn-4Zr-6Mo following wire electrical discharge machining (EDM), with minimum damage generator technology and optimized trim pass strategies. EDM surfaces, crack initiation was in some cases due to defects below the machined surface, with secondary cracks probably due to local stresses.Norliana Mohd Abbas,et.al.(2006) Review on current research trends in electrical discharge machining research trends in EDM on ultrasonic vibration, dry EDM machining, EDM with powder additives, EDM in water and modeling technique in predicting EDM performances.

II. EXPERIMENTAL WORK

2.1. Details of work piece and tool

Inconel work pieces have been spark eroded using copper as tool material. The workpiece used for this study was copper tungsten tool dimension of 100 mm×8 mm dia .The hardness of the work piece was 35 HRC. The tool electrode is the most critical part in the EDM. Copper has been chosen as the electrode material because of its lower electrical and thermal resistance. The tool tip diameter has been taken as 7 mm. The length of the electrode has been kept at 100mm so that maximum transfer of heat is possible away from the tool tip.

2.2. Methodology

Powder metallurgy is the process of blending fine powdered materials, pressing them into a desired shape or form (compacting), and then heating the compressed material in a controlled atmosphere to bond the material (sintering). The powder metallurgy process generally consists of four basic steps: powder manufacture, powder blending, compacting, and sintering. Compacting is generally performed at room temperature, and the elevated-temperature process of sintering is usually conducted at atmospheric pressure. Optional secondary processing often follows to obtain special properties or enhanced precision.Two main techniques used to form and consolidate the powder are sintering and metal injection molding. Recent developments have made it possible to use rapid manufacturing techniques which use the metal powder for the products.

Die Design and Fabrication: Mild steel is a type of steel that only contains a small amount of carbon and other elements. It is softer and more easily shaped than higher carbon steels. Some mild steel properties and uses: Mild steel has a maximum limit of 0.2% carbon. It is the cheapest and most versatile form of steel and serves every application which requires a bulk amount of steel. It is used in almost all forms of industrial applications and industrial manufacturing. It is a cheaper alternative to steel, but still better than iron. It is weldable, very durable, machinability, it is relatively hard and is easily annealed. BHN valuve of Mild steel is 130.

Due to these Mild steel solid rods are used to fabricate the die. Boring, turning and welding are used operations to get the die at required dimensions. The die design is splited into two parts, they are male and female dies. The male die is designed to move freely inside the female die.

Copper Tungsten cannot be manufactured by conventional alloying techniques, since the Copper would vaporize before the Tungsten begins to melt. That is why Copper Tungsten is made by the powder metal process. Copper and Tungsten powder are pressed into a pre-formed and then sintered. During sintering, the material shrinks by approximately 25% and great care must be taken to avoid porosity, which is a common defect in some Copper Tungsten electrodes. Copper Tungsten is generally sold in the 70Cu:30W grade. It is possible to purchase Copper Tungsten with different ratios. A higher copper content would improve the surface finish and cutting speed. A lower Tungsten content would increase the strength of the wire and gives more wear resistance.

III. EXPERIMENTAL SET-UP AND WORKING

Atomized copper powder is selected as base material and Tungsten is added with copper to prepare the billet. The metal powder mixer is loaded into the die and pressed into the form of billet by help of Universal Testing Machine. Copper based billet is so soft than others so pre heat is needed to handle freely. Table2 show the preheat temperature of the billets. Fig 6.1 shows the billet preparation by using a universal testing machine. The atoms in the powder particles diffuse across the boundaries of the particles, fusing the particles together and creating one solid piece, because the sintering temperature does not have to reach the melting point of the material. Table 5.2 and 5.3 illustrate the pre heat temperature and sintering temperature of the billets.

3.1 EDM machine specifications;

Machine make –electronica, 500x300mm length breath, hight175mm, Coolant fluid –kerosene Specifications voltage stabilizer capacity-5Kva Output-415v, 3phase, 50Hz, Hardness=55-60 HRC.

3.2 Cycle time:

The actual time it takes to perform a task and forward it to the next step. One of the major goals of lean is to match cycle time to takt time. The effects of machining time on cycle time reducing difference between on copper electrode, Cu-W electrode rod have been presented in fig 7.1and fig 7.2 shows the cycle time reduction in EDM process.Fig7.1 Copper rod electrode machining time.

3.3 Electrode wear ratio

An ideal EDM tool electrode should not only remove the maximum amount of material from the work piece, but should also be capable of resisting self-erosion. The electrical erosion resistance of EDM electrodes is determined by a combination of thermo-physical and mechanical characteristics . It has been found that discharge current, pulse on time and duty cycle have the most significant effect on the electrode wear ratio. Electrode wear ratio has been defined, as the ratio of the wear weight of electrode to the wear weight of work piece after machining and is given below Electrode wear ratio(%)=wear weight of electrode/wear weight of work piece*100

EWR (%)=W EBM- W EAM/W WBM-W WAM*100

3.4 Machining cost

Definition: One machine working for one hour,Electronica EDM machine cost per hrRs.125, Copper tungsten rod (70-30%) using an reducing the machining cost for mild steel per hr. Rs.4.80 and Inconel per hr. Rs.16.60

3.5 Optimization techniques: Fig 7.3 and fig 7.4 main effects plot for means and main effects plot for s/n ratio, S/N ratio and Means are calculated and various graph for analysis is drawn by using Minitab 15 software. The S/N ratio for MRR is calculated on Minitab 15 Software using Taguchi Method

IV. FIGURES AND TABLES

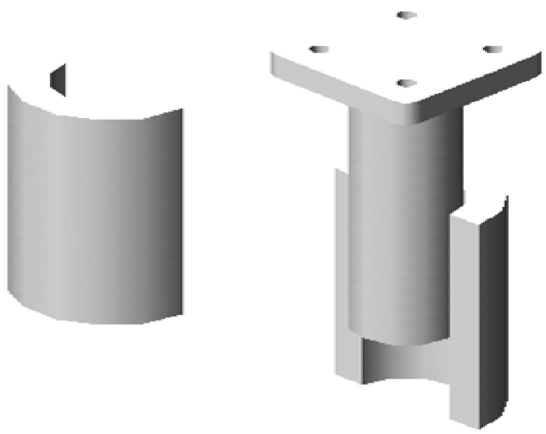


Fig.1. Die Assemble and Cut Section

Form	solid	Solid
Color	Brown	Irregular Fine particles.
Odour	Odourless	Odourless
Boiling Temperature	2323 C	5930ºC
Melting	1083 C	3370ºC
Density	8.93 m/cm³	19.3 gm/cm³

Table 1.1 Physical and chemical properties of Copper and Tungsten.

Si.no	Weight ratio		Temp in °c	TempDuration in hr.
	Cu	W		
1	70	30	1600	4
2	80	20	1200	4
3	90	10	800	4

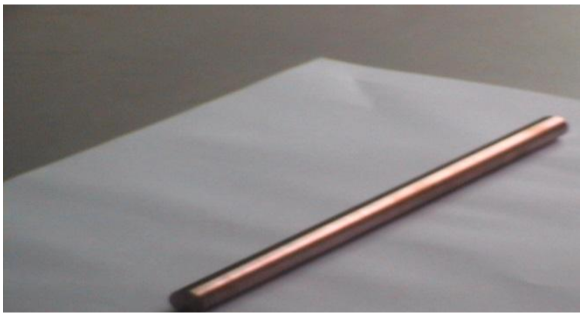
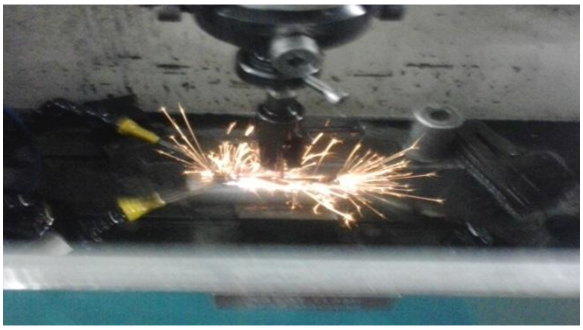


Fig 6.1 Copper tungsten rod after pre machining

Fig6.4 shows the details of work piece and tool on machining setup.



Cu electrode rod and Cu-W electrode rod for Inconel

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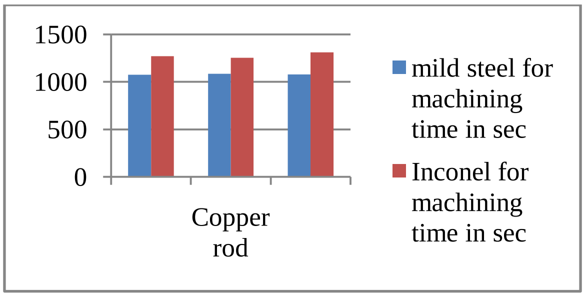
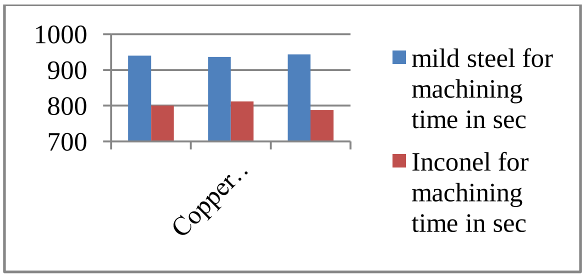


Fig7.1 Copper tungstenrod electrode machining time



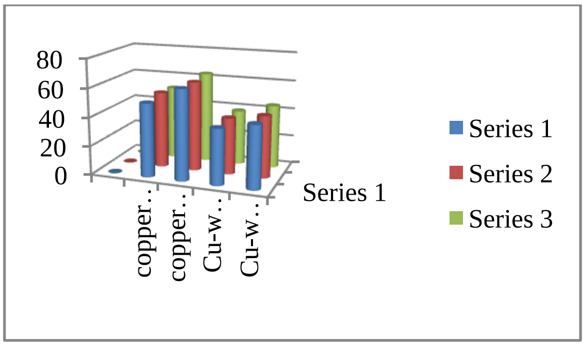
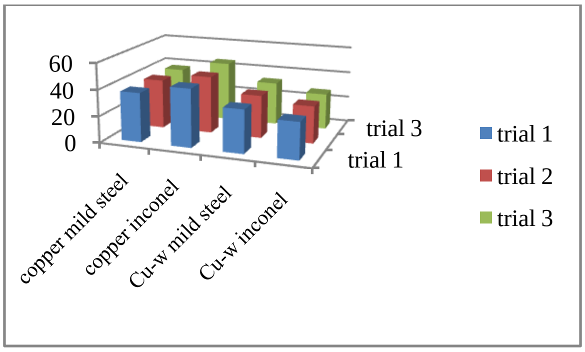


Fig 7.4 show the machining cost reduction



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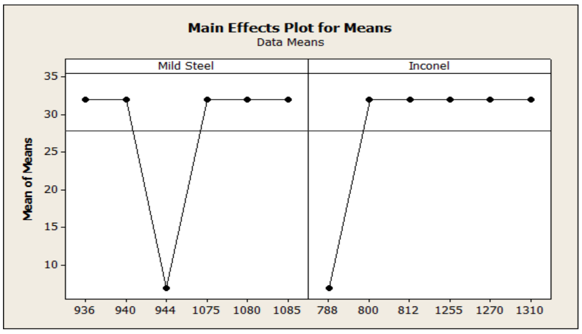

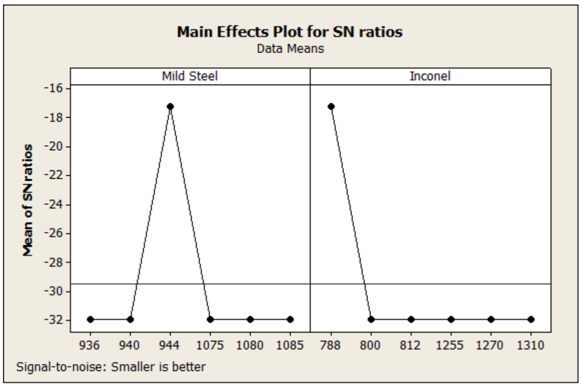

V. CONCLUSION

For the purpose of completely hard material machining on reducing the cycle time and tool wear rate generated in copper rod by EDM, on-the machining tool composition modification technology was developed in this study.

By applying this technology to a simple die, the tool wear rate defects generated by EDM could be completely removed by incorporating the copper tungsten rod Cu-w (70%-30%) composition process into EDM.The resulting tool wear rate, cycle time was reduced. So increase productions reduced cycle time, machining cost, tool wear rate and increase the surface finish.

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