EXPERIMENTAL INVESTIGATION ON NICKEL ALUMINIUM ALLOY BY ELECTRIC DISCHARGE MACHINE

Dinesh Kumar[1], Devendra Singh[2], Dr. Ajay Kumar Sharma[3]

[1]*Student, Sachdeva institute of Technology, Mathura, Mechanical engineering, AKTU, Lucknow , U.P.-India*
[2]*Asst. Prof. Mechanical Engineering, Sachdeva institute of technology, Mathura, U.P.-India*
[3]*Asst. Prof., Mechanical Engineering, Institute of Engineering & Technology, Lucknow, U.P.-India*

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Abstract - Advanced structural ceramics, such as Silicon Carbide (Sic), Silicon Nitride (Si_3N_4), Alumina (Al_2O_3) and Zirconia (ZrO_2) are attractive materials for many applications ranging from aero engines to dental restoration and is possible due to high hardness and strength, wear resistance, resistance to chemical degradation and low density. Various applications of these ceramic materials demand shaping to a high degree of surface finish and dimensional accuracy. These materials difficult to machine because of high hardness and abrasive nature of reinforcing elements like alumina particles. In this study, homogenized (4%, 6%, and 8%) by weight of alumina aluminum metal matrix composite materials were fabricated and selected as work piece for experimental investigations on electric discharge machine.

1. INTRODUCTION

Composite materials have been termed as the 'materials of the future' in 1970s when they were introduced in engineering applications. Composite material is a materials system composed of two or more dissimilar constituents, differing in forms, insoluble in each other, physically distinct and chemically inhomogeneous. Each of the various components retains its identity in the composite and maintains its characteristic structure and properties. These are recognizable interfaces between the materials. The resulting product possesses properties much differed from the properties of constituents materials, also referred as composites. Metal matrix composite (MMC) are widely used composite materials in aerospace, automotive, electronics and medical industries.

1.1 Metal-matrix composites:

MMCs can be used for operating temperatures up to 1250°C, where the conditions require high strength coupled with ductility and toughness. The ductile matrix material can be aluminum, copper, magnesium, titanium; nickel, super alloy, or even intermetallic compound, and the reinforcing fibers may be graphite, boron carbide, alumina, or silicon carbide. Fine whiskers (tiny needle like single crystals of 1 to 10 µm in diameter) of sapphire, silicon carbide, and silicon nitride have also been used as the reinforcement. Compared to the engineering metals, these composites offer higher stiffness and strength (especially at elevated temperatures), a lower coefficient of thermal expansion, and enhanced resistance to fatigue, abrasion and wear. Compared to the organic matrix materials they offer higher heat resistance, as well as improved electrical and thermal conductivity. They are nonflammable and do not absorb water and gases. Unfortunately, these materials are quite expansive, they vastly different thermal expansions of the components may lead to deboning, and the assemblies may be prone to galvanic corrosion.

2. Electro-Discharge Machining (EDM):

Electrical discharge machining (EDM) is a non-traditional manufacturing process where the material is removed by a succession of electrical discharges, which occur between the electrode and the work piece. These are submersed in a dielectric liquid such as kerosene or de-ionized water. The electrical discharge machining process is widely used in the aerospace, automobile and molds industries to machine hard metals and its alloys.

3. Characterization of work piece material:

Hardness, tensile strength and scanning electron microscope images have been characterized of work piece material. Hardness of composite is tested on the Rockwell hardness testing machine .The model of machine is Fine Engineering industries, S No. NR S. and pressure imposed capacity is 50kgf, 100kgf, 150kgf.

We had applied 100kgf at B scale 1/16'' ball penetration, of pressure on our three specimens of 15%, 20% &25% by weight in nickel particles reinforced aluminum metal matrix composite. Tensile strength of composite specimen is measured by universal testing machine. The maximum capacity of our UTM is 40,000 Kgf. When the composite specimens obtained from casting, their microstructure of 4%, 6%, and 8% will examined with the scanning electron microscope (SEM). The scanning electron microscope (SEM) is a type of electron microscope that images the sample surface by scanning it with a high-energy beam of electrons in a raster scan pattern.

3.1 Hardness Table-

Hardness value (BHN)			
Trial no.	% of Nickel (Ni) by weight		
	15%	20%	25%
Trial -1	97	111	118
Trial-2	98	113	121
Trial-3	97.5	112	119.5

3.2 Tensile strength Table-

Tensile strength (Kgf)			
Trial no.	% of Nickel (Ni) by weight		
	15%	20%	25%
Trial -1	1270	1440	1800
Trial-2	1290	1455	1795
Trial-3	1280	1447.5	1977.5

3. CONCLUSIONS –

In this work, EDM has been successfully performed on nickel reinforced aluminum composite material. Statistical models have been developed for predicting MRR and SR in EDM by correlating the input parameters, namely, discharge current, pulse-on time, duty cycle, and % of Ni. In EDM process, significant parameters have been identified and Taguchi was used to establish the adequacy of the model.

It has been observed that MRR is significantly affected by discharge current, pulse-on time and duty cycle. It has been found that MRR increases with the increase in discharge current. It is also observed that MRR decreases with the increase in pulse-on time initially but after a certain value of pulse-on time, MRR increases. MRR is found to be increasing with an increase in the duty cycle. The second order model developed for SR is statistically significant. It has been observed that discharge current and pulse-on time are significant parameters affecting SR. It has been observed that SR increases with increase in discharge current. An increase in pulse-on time increases the SR.

4. SCOPE FOR THE FUTURE WORK

The work presented in this thesis may be extended further in the following ways:

1. In place of Nickel reinforced Aluminum composite, investigate another composite such as AL Sic, Silicon Carbide (Sic), Silicon Nitride (Si3N4), etc. on EDM with different types of di- electric fluids.

2. We use dielectric fluid in place of Silicon oil and the MRR because due to the abrasive particle it provides better cleaning of cutting pieces. This process we will study in our future investigation.

3. We also think how to improve the MRR then we decided to design and construct the Rotational types electrode holder, this types of holder arrangement we are construct and also check it .at the same times the MRR is increases more due to vibrational effect .and surface finishing is not affected more but it is also maintained that.

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