Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

OPTIMIZATION OF WIRECUT EDM USING HCHCR BY TAGUCHI ANALYSIS

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ABSTRACT

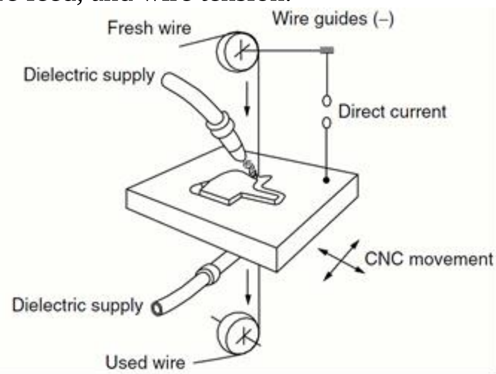
Wire electrical discharge machining (WEDM) is a specialized thermal machining process capable of accurately machining parts which have varying hardness, complex shapes and sharp edges that are very difficult to be machined by the traditional machining processes this research paper to optimize machining parameters of dimensional accuracy in wire cut electric discharge machining (WEDM). The effects of various process parameters of WEDM like pulse on time (TON), pulse off time (TOFF) and wire feed (WF). On different process response parameters such as material removal rate (MRR), surface roughness (Ra), with TAGUCHI analysis and Analysis of variance (ANOVA) is used to study the effect of process parameters on machining process. Have been investigated to reveal their impact on material removal rate (MRR) and surface roughness (Ra) of High carbon high chromium (HCHCr).

Keywords WEDM, SURFACE ROUGHNESS, MRR, TON, TOFF, WF.

INTRODUCTION

WEDM is a thermo- electrical process of the conventional EDM process which comprises of a main worktable, wire drive mechanism, a CNC controller, working fluid tank and attachments. The work piece is placed on the table and fixed by clamps and bolts. The table moves along X and Y-axis and it is driven by the DC servo motors. Wire electrode usually made of thin copper, brass, molybdenum or tungsten of diameter 0.05-0.30 mm, which transforms electrical energy to thermal energy, is used for cutting materials. The wire is stored and wound on a wire drum which can rotate at 1500rpm. During the WEDM process, the material is eroded ahead of the Wire and there is no direct contact between the work piece and the wire, eliminating the Mechanical stresses during machining. Also the work piece and the wire electrode (tool) are separated by a thin film of dielectric fluid that is continuously fed to the machining zone to flush away the eroded particles. The movement of table is controlled numerically to achieve the desired 3D shape and accuracy of the work piece.

At present, WEDM is a widespread technique used in industry for high-precision machining of all Types of conductive materials such as metals, metallic alloys, graphite, or some ceramic materials, of any hardness. The whole process depends on number of input process parameters such as pulse on time, pulse off time, servo voltage, peak current, dielectric flow rate, wire feed, and wire tension.



Working principle of WEDM

Mustafa Ilhan Gokler and Alp Mithat Ozanozu: The experimental study to select the most suitable cutting and offset parameter combination for the wire electrical discharge machining process in order to get the desired surface roughness value for the machined work piece. A series of experiments have been done on 1040 steel material of thicknesses 30, 60 and 80 mm, and on 2379 and 2738 steel materials of thicknesses 30 and 60 mm respectively. M.T. Antar, S.L. Soo, D.K. Aspinwall, D. Jones and R. Perez this paper mainly deals with a brief review of recent Minor damage EDM pulse generator developments, experimental data is given for work piece productivity & integrity when WEDM Udimet 720 nickel based super alloy and Ti-6Al- 2Sn-4Zr-6Mo titanium alloy, using Cu core coated wires (ZnCu50 and Zn rich brass). Up to a 70% increase in productivity was possible compared to when using uncoated brass wires with the same operating parameters. Surfaces measuring ∼ 0.6 ìm Ra, with near neutral residual stresses and almost zero recast were produced following two trim passes.

Swarup S. Mahapatra and Amar Patnaik The study of Parametric Optimization of Wire Electrical Discharge Machining (WEDM) Process using Taguchi Method. The paper outlines the development of a model and its application to optimize WEDM machining parameters.

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Kao et al [2006] It has been investigates the dry wire electrical discharge machining (EDM) on thin work pieces. This study also observed the deposition of debris in the groove cut by dry wire EDM. For a thick work piece, the groove was totally blocked. **Herreroa et al [2007]**. This present article exposes the theoretical analysis of some aspects of the thin WEDM that drop the process accuracy in terms of minimum machinable slot or corner over/undercutting. The scaled electrode dimensions and the reduced power supply with respect to the normal process causes a different influence of the process variables and contribute to obtain complementary information about the WEDM process. The different force components contributing to the wire deformation are discussed and some of them are analyzed from a theoretical point of view presenting analytical calculations to evaluate their expected magnitude and pointing out the difficulties to obtain an experimental characterization of each phenomenon.

J. T. Huangy and Y. S. Lioaz [2000] the paper mainly deals a prototype ANN-based expert system for the maintenance schedule and fault-diagnosis of Wire-EDM. The advantages of ANN algorithm and expert system, and this system is a powerful development tool for a complicated consulting system such as a Wire-EDM process. The system developed will help operators, even for novices and trainees in Wire- EDM, to maintain machines well, and eliminate faults sooner. Hence, the operating time can be minimized and the cost can be lowered. In the future, more examples will be provided so that the inferring reliability and accuracy of the system can be improved.

Machining parameters	Units	Level 1	Level 2	Level3
Pulse on time	µS	120	125	128
Pulse off time	µS	42	46	48
Wire feed	m/s	3	5	7

Qu et al [2006]. The feasibility of applying the cylindrical wire EDM process for high MRR machining of free-form cylindrical geometries was demonstrated in this study. The mathematical model for the MRR of cylindrical wire EDM of free-form surfaces was derived. Two experimental configurations designed to find the maximum MRR in cylindrical wire EDM were proposed. Results of each test configurations match each other, which validates the concept. The maximum MRR for the cylindrical wire EDM was higher than that in 2D wire EDM of the same work-material. This indicates that the cylindrical wire EDM is an efficient material removal process. The surface integrity and roundness of cylindrical wire EDM carbide and brass parts were investigated. Experiments demonstrated that good surface finish and roundness could be achieved in the cylindrical wire EDM process. The craters, recast layers, and heat-affected zones were observed, and their sizes were estimated using the SEM.

Work Piece	Pulse On Time (μS)	Pulse Off Time (μS)	Wire Feed (M/Sec)
HCHCR	120	42	3
HCHCR	120	46	5
HCHCR	120	48	7
HCHCR	125	42	5
HCHCR	125	46	7
HCHCR	125	48	3
HCHCR	128	42	7
HCHCR	128	46	3
HCHCR	128	48	5

S. K. Hargrove1 and James M. Ngeru [2008]. The main factors, which influences machining in Wire-EDM includes: electrical parameters and dielectric fluid. Due the nature of wire EDM machine, which is a spark erosion process, there is modification of surface layers structure, which is unfortunate phenomenon and is considered a serious flaw in work piece which reduces the longevity of the part useful life and material strength.

SELECTION OF FACTORS AND THEIR LEVELS

The determination of which factors to investigate depends on the responses of interest. The factors which affect the responses were identified using cause and effect analysis,

1. Three levels of pulse on time.
2. Three levels of pulse off time.
3. Three levels of wire feed.

High-carbon, high-chromium tool steel having extremely high wear resisting properties. It is very deep hardening, and will be practically free from size change after proper treatment. The high percentage of chromium gives it mild corrosion resisting properties in the hardened condition. It is available as a De Carb-Free product. DCF bars have been cold-finished in the mill therefore eliminating the need for bar bark removal. Carbon steel is steel where the main interstitial alloying constituent is carbon in the range of 0.12-2.0%.

Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

The work piece in the form of square plate of 200 mm x 200 mm size and 13mm thickness is mounted on the WEDM machine tool and cuts 9 circle which has diameter of 30mm have been obtained for each experiment. The close up view of plate being mounted on the machine work table is shown figure 3.4. A set of cut specimens after experimentation is shown in figure 3.5.

The set of trials performed according to the L9 Orthogonal Array for the experiment are shown in table 3.4 respectively

CONCLUSION

In this study, an attempt has been made to find the optimal combination of process parameters to obtain maximum material removal rate and minimum surface roughness using Taguchi technique as well as Gray relational analysis technique and the percentage contribution of process parameters and its influence on the output parameters were investigated using ANOVA. It is shown that the output parameters namely material removal rate (MRR) and surface roughness are improved in the optimal combination obtained by Taguchi technique and Gray relational analysis technique. The results were discussed in detail and from the results, the following conclusions are drawn:

The optimal combination of process parameters for obtaining maximum MRR through Taguchi technique for machining HCHCR steel using Wire-EDM is given below:

1. Pulse on time – 128 µS
2. Pulse off time – 42µS
3. Wire Feed – 3m/s

The optimal combination of process parameters for obtaining minimum surface roughness through Taguchi technique for machining HCHCR using Wire-EDM is given below:

1. Pulse on time – 128 µS
2. Pulse off time – 46µS
3. Wire Feed – 3m/s

The optimal combination of process parameters to obtain maximum material removal rate and minimum surface roughness through Gray relational analysis technique for machining HCHCRl using Wire-EDM is

1. Pulse on time – 120 µS
2. Pulse off time – 46µS
3. Wire Feed – 7m/s

The percentage contribution and the influence of process parameters on MRR and surface roughness were determined by using ANOVA, which gives the following results:

1. Pulse on time – 34.1785%
2. Pulse off time – 32.1342%
3. Wire Feed – 33.6869%

Finally, it was concluded that the pulse on time has more influence on the surface roughness and material removal rate, which is followed by pulse off time and wire feed

RECOMMENDATIONS FOR FUTURE WORK

Based on the observations and findings in this study, the future work might attempt to consider the other criteria proposed as follows:

- The effect of process parameters on response variables for material HCHCR has been investigated using WEDM, still there is scope of further investigation for other materials.
- Brass wire electrode (0.25 mm diameter) has been used for present investigation, however different types of wire materials as electrode need to be investigated for better understanding of WEDM.

Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

- The effect of process parameters such as flushing pressure, conductivity of dielectric, wire diameter, work piece height etc. may also be investigated.
- The effect of process parameters on response variables in different cutting environment may also be investigated.
- Priority weights assigned to different response variable for optimization of the process parameters should be based upon as per the requirement of the industry.

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