International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

Effect of Various Parameters on Machining of EN-31 in Wire Electrical Discharge Machining

Rajat[1], Shiv Kumar[2]

[1]SIRDA Institute of Engineering and Technology, Mechanical Engineering Department
trajat114[at]gmail.com

[2]SIRDA Institute of Engineering and Technology, Mechanical Engineering Department
er.shivkumar23[at]gmail.com

Abstract: ***With the increase in research activities in nuclear, automobile, aerospace industries and medical industries the need for micro machining process is also arising. Non-conventional machining with hybrid arrangement is more efficient as compared to the Conventional machining on the count of maximum material removal. Wire Electrical Chemical Discharge Machining (WEDM) is one of the best machining used for machining conductive as well as non-conductive material using the effect of electro discharge machining process. In this paper effect of various parameters of WECDM process on material removal of EN-31 is studied. The effect of spark/pulse on time, pulse off timer, peak current and wire feed showed significant effect on material removal.***

Keywords: Non-conventional machining, EDM, WEDM, Hybrid machining processes

1. Introduction

Need of harder materials in industry is increases daily, newer materials which have higher hardness are presented into the market. The machining of these types of materials is very difficult with the old-fashioned machining processes due to their increased hardness. Therefore non-conventional machining methods as electro discharge machining, wire electrical discharge machining. It comes into play when electrically conductive materials are to be machined. Wire Electrical Discharge Machine is a variation of electrical discharge machining. The basic principle of both electrical discharge machine and wire electrical discharge machine is same. The erosion of work piece took place by no. of electrical sparks. The Potential difference is applied between the tool (wire acts as tool in this process) and work piece, the dielectric is ionized and spark is emerges out which strikes the work piece and the erosion of work piece material took place. Dielectric used is of kerosene oil and sometimes it is of distilled water. The difference between both processes i.e. wire electrical discharge machine and (EDM) electrical discharge machine is that in the case of WEDM a constantly fed wire (Vertical in position) (tool) is fed into the work piece. The same wire can be used for machining different complex shapes. However, in case of electrical discharge machining the tool has to be changed according to the required profile of work piece. Now a days Wire Electro Discharge Machining is gaining its use in various industries and used to make dies, mould and medical equipment [1]. Wire Electro Discharge Machining is a machining process which removes material by providing thermal gradients at the point of machining area and removes material [2]. When material is machined through conventional processes they have very sharp edges and difficult to handle. Such materials are very difficult to machine through conventional processes [3]. The origin of Wire Electro Discharge Machining is basically initiated from the EDM process and spark is created at the desired area [4]. The principle of WEDM is same as the principle of EDM process. In WEDM, electrical work pieces are manufactured with order of discrete electrical discharge which are formed among a constantly fed wire electrode and the material which is to be machined. The Pluses of current are comes out of the moving electrode to work piece with fine gap over non-conducting deionized water. Infinite electrical sparks can be professed at the same moment. The sparks lasts only for microseconds. The temperature of that individual electrical sparks is around 8000 °C to 12,000° Celsius, wears down a little of material is turned to vapor and comes in the form of liquid from the work material. Same time a little amount of wire electrode is also got eroded and little craters were formed on wire, These tiny particles (chips) are moved from the machined area with the help of dielectric water by the upper and bottom flushing outlets on machine heads. The dielectric also makes the work piece cooler one. In absence of cooling effect, expansion of the part occurs and it disturbs the dimensions and positional accuracy of the machined material. Various parameters are optimized in WEDM to enhance material removal rate [5]. One of the best parameter optimization technique known as artificial neural network is very popular in designing process parameter in WEDM [6]. Many researchers are using this technique to evaluate the effect of various parameters on material removal rate of various materials in WEDM.

2. WEDM process parameters

Input parameters and also their range selected on the bases of performing the test by pilot. The input parameters selected were:

Pulse (Off Time):
Spark of pulse (off time) represented as T_{off}. This denotes extent chronologically consumed in microsecond (μs) amongst the two continuous sparks. The voltage of system is lacking during this portion of the cycle. During pulse off time if value of electric discharge is very low the wire can break and cutting efficiency becomes very low [7].

Pulse (On Time):
Spark of pulse (on time) is represented by T_{on}. This denotes extent chronologically consumed in microseconds (µs) during energy applied on running respective set. The voltage (Vp) is applied against cathode and anode in this period. Higher value of electric discharge sometimes breaks the wire.

Peak Current:-
The maximum Current is represented by (Ip) and peak value of the charge moving over the electrodes for the particular pulse at particular time. The process parameter is very useful in making surface surface [8]

Wire Feed or Wire Speed:-
Wire speed is another important parameter in WEDM. It shows the speed of wire in WEDM. The wire speed increases the wire consumption. The result in the cost of machining will increases while low wire speed can cause to wire breakage in high cutting speed. If the wire speed is very low the wire breakage can occur [9]

3. Result and Discussions

Study of change in material removal rate and surface roughness with t_{on}:
Initially spark/pulse on time (T_{on}) varies to get their effect on (MRR), (SR). The change in material removal rate & surface roughness with (T_{on}) shown in table below. The other factors were kept constant as: pulse (off time) on 60 units peak current on 230 units, wire fed on 3 units and wire tension on 10 units. The effect of T_{on} is shown in Figure 1. It is clear from the fig that with increase in T_{on} material removal rate as well as surface roughness of material increases.

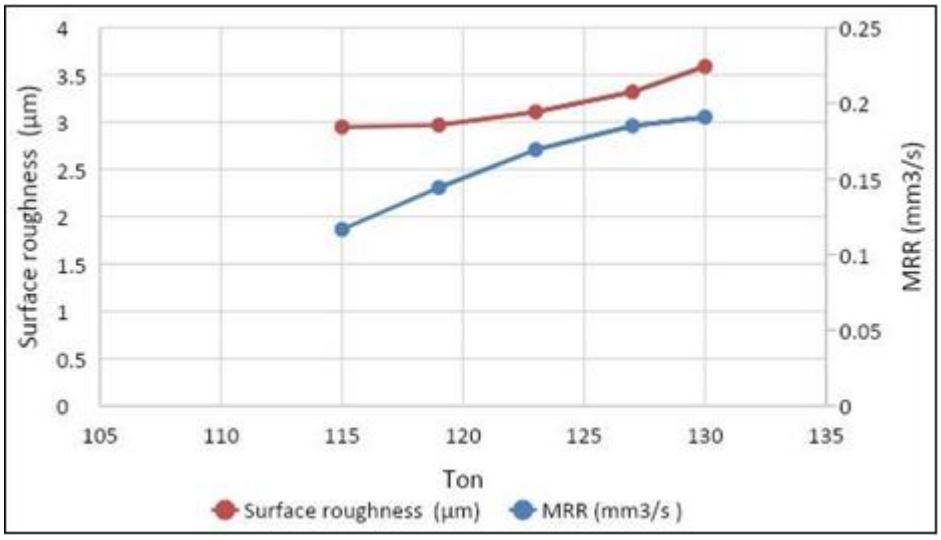

Figure 1: Change in material removal rate and surface roughness with t_{on}

Study of material removal rate and surface roughness with t_{off}
Now the value of the pulse off timer (T_{OFF}) varied to find out their effect in (MRR), (SR).The below table 6 shows the change in MRR, SR (vs) (T_{Off}) .The other parameters as per earlier were kept constant as: pulse (on time) on 118 units peak current on 230 units, Wire was fed on 3 units and wire tension on 10. The effect of T_{off} is shown in Figure 2. It is clear from the fig that with increase in T_{off} material removal rate as well as surface roughness of material decreases.

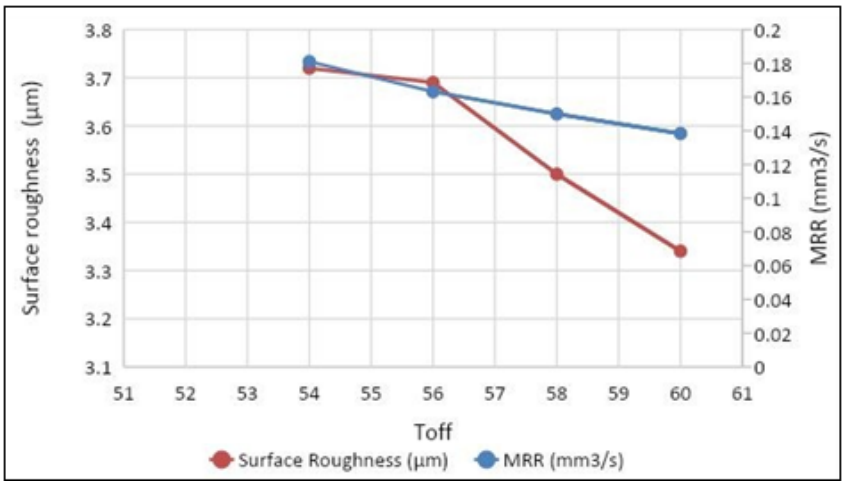

Figure: 2 Study of material removal rate and surface roughness with t_{off}

Study of material removal rate and surface roughness with I_p

Now the values of I_p (peak current) were varies and find out their effect on (MRR), (SR). The variations of (MRR), (SR) along I_p. The remaining parameters were kept constant as: P on (pulse on time) on 118 units, p off (pulse off time) on 60 units, Wire fed rate at 3 units and tension of wire on 10 units. The effect of I_p is shown in Figure. It is clear from the figure 3 that with increase in I_p material removal rate as well as surface roughness of material increases. At initial stage no significant change in material removal rate was observed.

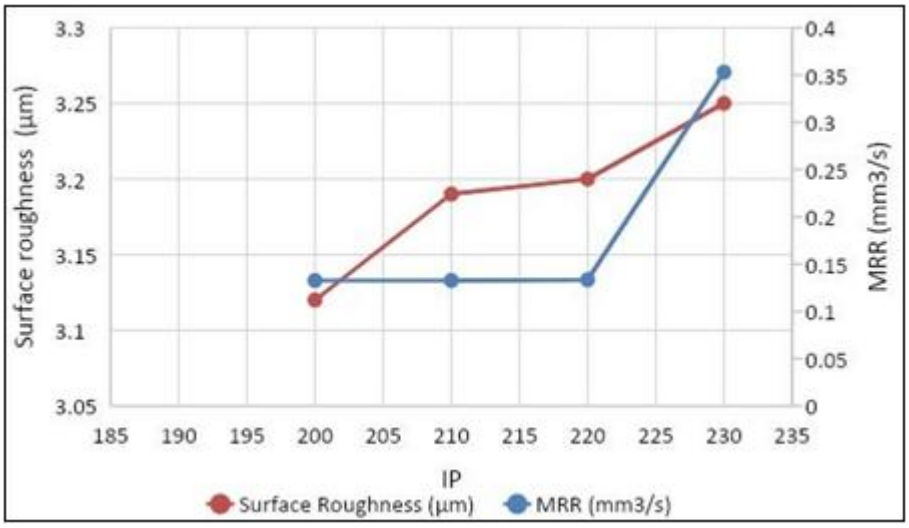

Figure: 3 Study of material removal rate and surface roughness with I_p

Study of material removal rate and surface roughness with W_f

Now the values of (W_f) wire feed were varies and find out their effect on (MRR), (SR). The change of (MRR) and surface roughness with (W_f). The other parameters were remains same as: spark (on time) (T_{on}) on 118 units spark (off time) (T_{off}) on 60 units, peak current (I_p) is on 230 units, tension of wire on 10 unit respectively. The effect of W_f is shown in Figure 4. It is clear from the fig that with increase in W_F material removal rate as well as surface roughness of material increases.

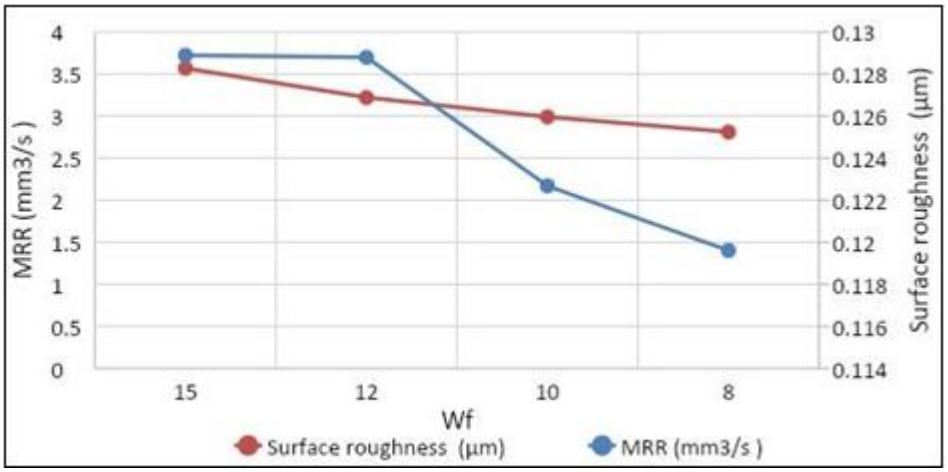

Figure: 4 Study of material removal rate and surface roughness with W_f

4. Conclusion

Wire Electro Discharge Machining has been found a very impressive technique to remove material from the conductive as well as no conductive material. Various parameters of WEDM showed significant increase in material removal rate of EN-31.

When pulse on time (T_{on}) increases from 115 to 130 material removal rate of 0.11665 to 0.19098 (mm^3/s) was observed. The surface roughness also increases for respective parameters. When the pulse off timer (T_{OFF}) increases from 54 to 60 material removal rate of 0.18101 to 0.13838 (mm^3/s) was observed. The surface roughness also increases for respective parameters. When the values of I_p (peak current) increases from 200 to 230 surface roughness of 3.12 to 3.25 (µm) was observed.

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Author Profile

Rajat received B.Tech degree in Mechanical Engineering and currently doing M.Tech in Mechanical Engineering from SIRDA Institute of Engineering and Technology. Currently he is exploring his knowledge in the field of mechanical engineering and doing research in the field of non-conventional machining especially in the Wire Electric Discharge Machining.

Shiv Kumar received B. Tech degree in Mechanical Engineering and Master degree in engineering field. Currently he is working as assistant professor in Mechanical Engineering department at SIRDA Institute of Engineering and Technology. He has huge knowledge in academic as well as industrial organizations. He published various papers in reputed journal and guiding M.Tech students in research work.