Performance of electric discharge machining for different steels.

Mahindrakar V.N.,
Lecturer, Mechanical Engineering Department, College of Engg., Malegaon(BK), Tal- Baramati, Dist- Pune.

Pimpalgaonkar B. S. SIR
Lecturer, Mechanical Engineering Department, M.G.M's, College of Engg, Nanded.

ABSTRACT
The electric discharge machining process involves finite discrete periodic sparks between tool electrode & conductive work electrode separated by a thin film of liquid dielectric that causes the removal of work material.

The selection of EDM parameters is very important in determining MRR & surface finish obtained for particular work material. Parameters are manually selected on most EDM systems, although some recently available systems use CNC units or programmable controllers to adjust & match parameters for various applications.

The present study deals with EDMing performance of different grade steels such as EN-8 & EN-24. The experimental study is decided to optimize the process parameters for MRR & surface finish. The relative changes in MRR, surface finish & tool wear with different duty cycles are investigated. It has been observed that EN-8 & EN-24 are more sensitive to surface finish, at the same time higher MRR is observed with lower duty cycles.

The observed values of MRR, surface finish & tool wear per duty cycle is represented in graphical form. And according to these graphs, proper duty cycle can be selected with respect to MRR & surface finish.

General Terms
EDMing- Electric discharge machining., MRR- Metal Removal Rate, S.F.- Surface Roughness, T.W.- Tool Wear

Keywords
EDMing- Electric discharge machining, MRR- Metal Removal Rate.

1. INTRODUCTION
New development in engineering industry has always brought about challenging tasks. To fulfill the air craft, missile, & nuclear industries, the materials such as ceramics, carbides, high strength temperature resistance alloys, stainless steels, nitro alloy, tantalum, beryllium, tungsten, uranium etc. were developed. These material possess high strength to weight ratio, hardness & heat resisting qualities. These materials are extremely hard & difficult to machine by conventional machining processes in spite of recent technological developments. Moreover, machining of these materials into complex shapes is difficult, time consuming, uneconomical & sometimes impossible. This has lead to search & development of new unconventional (non-traditional) methods of machining. These processes are called non-traditional or unconventional because they do not employ conventional tool for metal removal. In these processes some form of energy is directly utilized for metal machining.

EN grade steels have proved that, they are best candidate materials in power transmitting shafts and die/tool manufacturing. In case of tool design and manufacturing the surface quality may become more predominant factor. Earlier studies data consolidation is difficult due to variety of machines, different process parameters, materials etc. In view of this objectives formulated are as below.

- To study EDMing at constant current by varying duty cycles.
- To study relationship between surface finish and tool wear with respect to duty cycle.
- To observe machining time with respect to duty cycle.
- To study effect of tool wear on MRR.
- To evaluate wear ratio per duty cycle.
- To generate data base for MRR, surface finish & tool wear.

2. EXPERIMENTAL SET UP :
As per objectives of experimentation to analyze MRR, tool wear & surface finish. The experimental parameters which are selected are as follows. For the experimentation, the machine used is of the model **"ELECTRA EMS 5030".**

1.	Depth of cut in mm	0.2
2.	Current in AMPS	06 (CONSTANT)
3.	ON time	01,03,05,07
4.	Duty cycles	01,03,05,07(5,4,3,2)
5.	Oil pressure in Kg/Cm^2	0.3

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6. Tool material Graphite
7. Tool shape Cylindrical
8. Tool size in mm 12
9. Stop watch least count in Seconds 0.01
10. In built micrometer least count in mm0.001
11. Work piece materials used for experimentation EN-8 & EN-24.By selecting above experimental parameters, experimentation is carried out & it's observations & results are discussed below. The compositions of the materials selected is shown below. The materials are tested in Mattest laboratory, Waluj, Aurangabad.

Material	C	Si	Mn	P	S	Cr	Mo
EN-8	0.378	0.183	0.506	0.024	0.023	0.033	0.011
EN-24	0.423	0.198	0.634	0.024	0.022	1.37	0.223

3. EXPERIMENTAL PROCEDURE:

As per the parameters discussed experimentation is carried out. For experimentation, graphite tool having diameter 12 mm is used. The depth of machining is decided as 0.2 mm for all experiments.

By keeping 06 Amp current constant & changing duty cycles from 01 to 07 experimentation is carried out. For each experiment, machining time is noted by using stop watch of least count 0.01 sec. & the depth of machining is controlled by giving auto feed to electrode using in built micrometer having least count 0.001 mm. As soon as depth of machining is achieved machine gives beep & machining is automatically stopped.

4. RESULT & DISCUSSION:

The experimental comes out are discussed as, the various aspects regarding process parameters & their effects are discussed. The main aspect studied is the effect of duty cycle on MRR, surface finish &tool wear. Apart from this reduction in MRR & improvement in surface finish during selected duty cycles.

5. RESULT:

In this section, experimental results are tabulated as per observations. The experimentation on EN-grade steels provided database for selecting proper machining parameter according to MRR & surface finish. The results presented in this section are in the preview of constant current EDM operation. The results tabulated provide a guideline for maximum productivity & relatively better MRR with desirable surface finish.

Sr. No.	Duty cycle	EN-8	EN-24
01	01	00	00
02	03	0.02/2.23= 0.00896	0.02/3.18= 0.00628
03	05	0.05/7.34= 0.006812	0.04/16.30= 0.002454
04	07	0.07/40.08= 0.001746	0.05/39..12= 0.001278

5.1 Effect of duty cycle on MRR:

Machining Time (min.)

Sr. No.	Duty cycle	EN-8	EN-24
01	01	1.33	1.46
02	03	2.23	3.18
03	05	7.34	16.30
04	07	40.08	39.12

Sr. No.	Duty cycle	EN-8	EN-24
01	01	1.8045	1.6438
02	03	1.0762	0.7547
03	05	0.3269	0.1472
04	07	0.0598	0.0613

Material Removal Rate (MM^3/Min.)

It is observed that MRR decreases with increase in duty cycle for constant current EDM operation. The investigation is tabulated in above table. From above table it is observed that the MRR decreases as the duty cycle increases for all the samples of materials. For all materials, the MRR ranges from 0.0384 to 1.8 mm^3/min. & EN-8 is having the highest MRR for duty cycle 01.

Tool Wear MM^3/ Duty cycle:

Sr. No.	Duty cycle	EN-8	EN-24
01	01	00	00
02	03	0.02	0.02
03	05	0.05	0.04
04	07	0.07	0.05

Tool Wear MM^3/Min. :

Tool Wear MM^3/Min. = Tool Wear for each duty cycle/ Machining time for that duty cycle

The observations shows, the tool wear for different selected materials. It is observed that tool wear per duty cycle increases with higher duty cycle. Toll wear is higher in EN-8, as compared to EN-24 for lower duty cycle no. 01. Tool wear is 00 mm3 for duty cycle (01).

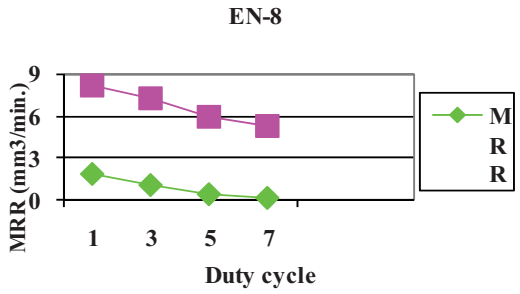
The above table gives the tool wear/min. Tool wear per minute goes on decreasing as we increase duty cycle.

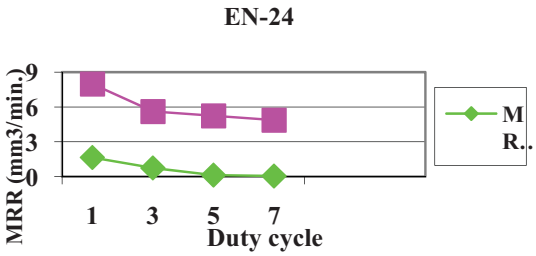
5.2 Surface Finish:

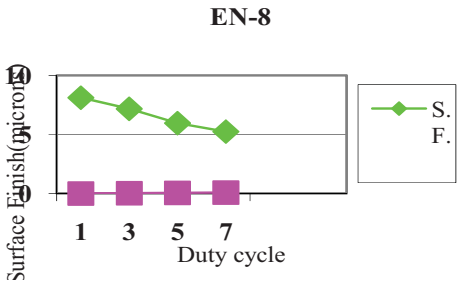
Average surface finish in microns (Ra)

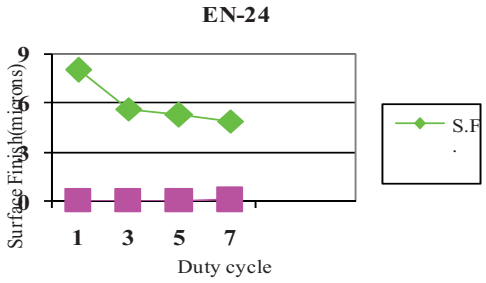
Sr. No.	Duty cycle	EN-8	EN-24
01	01	8.116	8.003
02	03	7.173	5.63
03	05	5.95	5.24
04	07	5.24	4.88

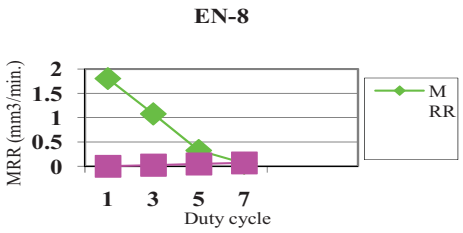
Variation of surface finish with duty cycle for different selected materials under investigation has mentioned in table. Common trend of better surface finish with increase in duty cycle has been observed for all materials under considerations.

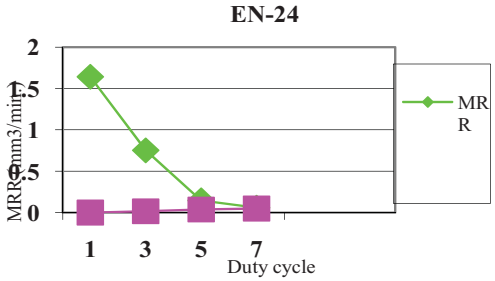












6. CONCLUSIONS:

Based on the experimental results the following conclusions are drawn.

- In electric discharge machining, it is observed that duty cycle is predominant factor.
- Longer the spark is sustained more is material removal.
- Since relation between surface finish & tool wear is hyperbolic, finer crater formation lead to more tool wear.
- Relatively higher MRR is achieved during electric discharge machining of harder materials.
- As tool wear is inversely proportional to MRR & surface finish, wear ratio goes on increasing as finer surface is obtained.
- Database for MRR, Surface finish & Tool Wear will help in selection for a specific application.
- As tool wear values are very less, we can conclude that when we use graphite as a tool for machining above materials, tool wear is negligible. It means that use of graphite tool is very beneficial.

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