

# **MATHEMATICAL MODELING OF MRR FOR ELECTRICAL DISCHARGE MACHINING**

**A Major Project thesis Submitted in partial fulfillment of the  
requirement for the award of the degree of**

**Masters of Technology**

*in*

**Production Engineering**

**Submitted By:**

**MANOJ KUMAR SINGH**

**ROLL NO: 2K10/PRD/17**

**UNDER THE GUIDENCE OF**

**Dr. Vipin**

**Professor**



**Mechanical Engineering Department  
DELHI TECHNOLOGICAL UNIVERSITY**

## **CANDIDATE’S DECLARATION**

I hereby declare that the work done in this project entitled **“MATHEMATICAL MODELING OF MRR FOR ELECTRICAL DISCHARGE MACHINING”** in the partial fulfillment for the award of degree of **“MASTER OF TECHNOLOGY”** with specialization in **“PRODUCTION ENGINEERING”** submitted to Mechanical Engineering Department of Delhi Technological University, Delhi is an authentic record of my own work carried out under the supervision of Dr. Vipin, Professor, Department of Mechanical Engineering, Delhi Technological University, Delhi. I have not submitted the matter in this dissertation for the award of any other Degree or Diploma or any other purpose whatsoever.

(MANOJ KUMAR SINGH)  
2K10/PRD/17

## **CERTIFICATE**

This is to certify that dissertation entitled “**MATHEMATICAL MODELING OF MRR FOR ELECTRICAL DISCHARGE MACHINING**” being submitted by **MANOJ KUMAR SINGH** in the partial fulfillment for the award of degree of “**MASTER OF TECHNOLOGY**” with specialization in “**PRODUCTION ENGINEERING**” submitted to **Department of Mechanical Engineering, Delhi Technological University, Delhi**, is a bonafide work carried out by him under my guidance and supervision.

The matter in this dissertation has not been submitted to any other university or institute for the award of any degree.

**Dr. Vipin,**

**Professor**

**Department of Mechanical Engineering**

**Delhi Technological University, Delhi -110042**

## **ACKNOWLEDGEMENT**

I express my sincere gratitude to my guide, **Dr. Vipin**, Professor, Mechanical Engineering, DTU, for valuable guidance, proper advice and constant encouragement during my project work. I also feel very much obliged to Dr. B. B. Arora, Associate Professor, Department of Mechanical Engineering for his encouragement and inspiration for execution of the project work.

I am also very much thankful to Prof. B.D. Pathak, HOD, Mechanical Engineering, Dr. Qasim Murtaza, Associate Prof., Dr. Parvin Kumar and Sh. Girish Kumar, Astd. Prof., Mechanical Engineering for time to time encouragement during evaluation of my project.

I am also thankful to Sh. Jeganathan Arul Moni, Associate Prof., W/S incharge, Sh. P.K. Jain, M/c shop incharge for the cooperation during working in M/c shop and Mr. Pardeep, Sr. Technician and Mr. Sunil, Jr. Technician without whom sincere and honest cooperation it was difficult to conduct the machining operation during my project work.

I am deeply indebted to my family for their inspiration and ever encouraging moral support, which enabled me to pursue my studies. I also very thankful to the entire faculty and staff members of Mechanical engineering Department for their direct and in-direct help and cooperation

(MANOJ KUMAR SINGH)  
2K10/PRD/17

## ABSTRACT

The right selection of manufacturing parameters is one of the most important aspects in the electrical discharge machining operation as these conditions has important effect on material removal rate (MRR). In this work the experiments are conducted on the machining of EN 31 die steel with graphite electrode in electrical discharge machining (EDM). The EDM oil commercial grade has been used as dielectric fluid. The effect of various EDM parameters such as discharge current,  $T_{on}$  and  $T_{off}$  has been investigated to yield the response in terms of MRR. In this work mathematical models have been developed for relating the MRR with machining parameters like discharge current,  $T_{on}$ , and  $T_{off}$ . The optimum value has been determined with the help of main effect plot and Annova table. With the help of MINITAB 15 software mathematical modeling has been done. The optimum value for MRR has been determined.

*Keywords: Electrical discharge machining (EDM), Material removal rate (MRR), ANNOVA (analysis of variance).*

## CONTENTS

TOPICS		PAGE NO
Certificate		ii
Acknowledgement		iii
Abstract		iv
Contents		v
List of Tables		vi
List of Figures		vi
List of graphs		vi
Chapter-1 Electrical Discharge Machining		1-8
1.1	Introduction	1-3
1.2	Process Description	3
1.3	Characteristics of EDM	3-4
1.4	Dielectric System	4-6
1.5	Pressure Gauge	6
1.6	Flushing Technique	6-8
1.6.	Flushing	6-7
1.6.	Suction Flushing	7
1.6.	Side Flushing	7
1.6.	Flushing by Dielectric pumping	7
1.6.	Injection Flushing	7
Chapter-2 Literature Review		9-17
Chapter-3 Experimental Set-Up		18-30
3.1	3.1 Introduction	18
3.2	Control Panel Description	19-21
3.3	Pendent Panel Description	21-22
3.4	Controller Description	22-23
3.5	Setting of workpiece for spark erosion	24-25
3.6	Process Parameters	25-29
Chapter-4 Mathematical Modeling		30-33
Chapter-5 Experimental Analysis		34-50
Chapter-6 Conclusion and Future Scope of Work		51-52
6.1	Conclusion	51
6.2	Future Scope of Work	52
	References	53-54

## LIST OF TABLES

NO.	DESCRIPTION	PAGE NO.
1	Machining Parameters	35
2	Machining Condition Used During Experimentation	36
3	Values of variables at different level	36
4	Experimental results of MRR with 3 <sup>N</sup> Factor	37
5	Experimental results of MRR with log value	39

## LIST OF FIGURES

NO.	DESCRIPTION	PAGE NO
1	Schematic representation of the basic working principle of EDM process	3
2	Injection Flushing	8
3	Side Flushing	8
4	Electrical discharge machine (model sn-35)	18
5	Control Panel	19
6	Shows effect of current on surface	26
7	Concept of Pulse on Time and Pulse off Time	27
8	Frequency setting	28
9	3 <sup>3</sup> full factorial design	35
10	EDMed Surface	38
11	Graph between Current and Ton at Toff=3	41
12	Graph between Current and Ton at Toff=4	41
13	Graph between Current and Ton at Toff=5	42
14	Graph between Current and Ton at Toff=6	43
15	Graph between Current and Ton at Toff=7	43
16	Graph between Current and Toff at Ton=4	44
17	Graph between Current and Toff at Ton=5	45
18	Graph between Current and Toff at Ton=6	45
19	Graph between Current and Toff at Ton=7	46
20	Graph between Current and Toff at Ton=8	47
21	Graph between Ton and Toff at Current=8	47
22	Graph between Ton and Toff at Current=9	48
23	Graph between Ton and Toff at Current=10	49
24	Graph between Ton and Toff at Current= 11	49
25	Graph between Ton and Toff at Current=12	50