result into accountable sources and thus finds the parameters whose contribution to total variation is significant. Thus analysis of variance is used to study the relative influences of multiple variables, and their significance.

The purpose of ANOVA is to investigate which process parameters significantly affect the quality characteristic. The analysis of the experimental data is carried out using the software MINITAB 14 specially used for design of experiment applications. In order to find out statistical Significance of various factors like pulse on time (A), pulse of time (B), and peak current (C), and their value on MMR, analysis of variance (ANOVA) is performed on experimental data. Table 4 shows the result of the ANOVA with the MMR. The last column of the table indicates p-value for the individual control factors. It is known that smaller the p-value, greater the significance of the factor. The ANOVA table for S/N ratio (Table 4) indicate that, the pulse on time (p=0.03), pulse off time (p= 0.697) and peak current (p=0.488) in this order, are significant control factors effecting MMR. It means, the pulse on time is the most significant factor and the pulse off time has less influence on the performance output.

Table -6: Analysis of Variance for SN ratios

Source	*DF*	*Seq SS*	*Adj SS*	*Adj MS*	*F*	*P*
Ton	2	0.00000	0.0000	0.0000	25.95	0.037
Toff	2	0.00000	0.0000	0.0000	0.43	0.697
IP	2	0.00000	0.0000	0.0000	1.05	0.488
Residual Error	2	0.00000	0.00000	0.0000		
Total	8	0.00000				

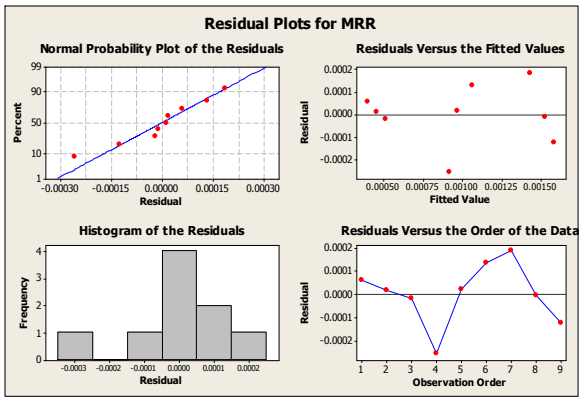

Chart 2: Residual Plots for MMR

4.3 Regression Analysis

Regression analysis is used for explaining or modeling the relationship between a single variable Y, called the response, output or dependent variable, and one or more predictor, input, independent or explanatory variables Mathematical models for process parameters such as pulse on time, pulse off time and peak current were obtained from regression analysis using MINITAB 14 statistical software to predict MMR.

The regression equation is

MRR = - 0.00571 + 0.000053 Ton + 0.000014 Toff - 0.000001 IP

S = 0.000166336 R-Sq = 92.5% R-Sq(adj) = 88.1%

Where,
Y = Response i.e. MRR
A = pulse on time (µs), B = pulse off time l (µs), C = peak current (Amp),

If we put optimum parameters which are drawn by ANOVA in equation 1 it will give optimum value of quality characteristic which will maximum MMR.

Yopt = - 0.00571 + 0.000053* A3 + 0.000014*B1 - 0.000001 *C3
Yopt = - 0.00571 + 0.000053* 130 + 0.000014*30 - 0.000001*230
Y opt = 0.0016 (Predicted by Regression Equation)

In multiple linear regression analysis, R2 is value of the correlation coefficient and should be between 0.8 and 1. In this study, results obtained from MMR in good agreement with regression models (R2>0.80).

Observation	Optimum Experimental value of MRR	Optimum Predicted Value	S/N Ratio
	0.00162	0.0016	-55.8097

5. Conclusions

The Taguchi method was applied to find an optimal setting of the material removal rate parameters process. The result from the Taguchi method chooses an optimal solution from combinations of factors if it gives maximized normalized combined S/N ratio of targeted outputs. The L-9 OA was used to accommodate three control factors and each with 3 levels for experimental plan selected process parameters are pulse on time (110,120,130 µs), pulse off time (30, 35, 40 µs), peak current (190, 210, 230 A). The results are summarized as follows:

- Among three process parameters pulse on time followed by pulse off time and peak current was most influencing parameters on MMR
- The Optimal level of process parameter were found to be **A3B1C3**
- The prediction made by Taguchi parameter design technique is in good agreement with confirmation results
- The result of present investigation are valid within specified range of process parameters
- Also the prediction made by Regression Analysis is in good agreement with
- The optimal levels of MMR process parameters for optimum MMR are:

Pulse On Time. (µs)	130
Pulse off Time l (µs)	45
Peak Current (Amp)	1

References

[1] Amir Ghaffari Bin Khalid, **"**Analysis Of The Influence Of Edm Parameters On Surface Quality, Mrr And Ew Of Wc–Co"
[2] Rohit Garg , Dr. Hari Singh "Effect Of Process Parameters On Performance Measures Of Wire Electrical Discharge Machining"
[3] R.A. Mahdavinejad , A. Mahdavinejad ,"ED machining of WC–Co" Mechanical Engineering Department, Faculty of Engineering, University of Tehran, Tehran, Ira
[4] M.Geetha, Bezawada Sreenivasulu, G. Harinath Gowd "Modeling & Analysis of performance characteristics of Wire EDM of SS304" ,
[5] Pandey PC, Jilani ST, "Electrical machining characteristics of cemented carbides", Wear 116, pp. 77–88, 1987
[6] Lee SH, Li XP, "Study of the surface integrity of the machined work piece in the EDM of WC", Journal of Materials Processing Technology 139, pp. 315–321, 2003.
[7] C.Y. Ho, and Z.C Lin, , "Analysis and application of grey relation and ANOVA in chemical mechanical polishing process parameters", Int. J. Adv Manuf. Technol.,21, 10–14, (2003)
[8] J. A. McGeough, "Advanced Methods of Machining", Chapman and Hall, New York, 1988
[9] S. S. Mahapatra & Amar Patnaiks "Optimization of wire electrical discharge machining (WEDM) process parameters using Taguchi method"
[10] F.R.M. Romlay and A. Mokhtar.,2008 "Machine Parameter Optimization for WEDM Machining".
[11] Ahsan Ali Khan, Mohammad Yeakub Ali and Md. Mohafizul Haque, 2009 "A study of electrode shape configuration on the performance of die sinking EDM"
[12] Muhamad Haniffah Bin Ghafar Dec.2010 " Surface integrity of mild steel in die-sinking electrical discharge machine (EDM)"
[13] Amir Ghaffari Bin Khalid., November 2008., "Analysis of the influence of EDM parameters on surface quality, MRR and EW of WC–CO"
[14] S.H.Tomadi, M.A.Hassan, Hamedon, IAENGR. Daud, A.G.Khalid (March 18 2009).,"Analysis of the Influence of EDM Parameters on Surface Quality, Material Removal Rate and Electrode Wear of Tungsten Carbide".
[15] Taguchi G, Konishi S. "Taguchi methods, orthogonal arrays and linear graphs, tools for quality" American supplier institute. American Supplier Institute; 1987 [p. 8–35].
[16] "Taguchi G. Introduction to quality engineering". New York: Mc Graw-Hill; 1990
[17] Mohd Amri Lajis, H.C.D. Mohd Radzi, A.K.M. Nurul Amin., 2009 "The Implementation of Taguchi Method on EDM Process of Tungsten Carbide"
[18] Chang-Ho Kim "Influence of the Electrical Conductivity of Dielectric on WEDM of Sintered Carbide"
[19] B. Puri, B. Bhattacharyya., 11 August 2004 "Modeling and analysis of white layer depth in a wire-cut EDM process through response surface methodology

Author Profile

Miss. V. P. Baisane pursuing ME - Manufacturing from MIT college of Engineering, Aurangabad, MH, India

Mr. Y.S. Sable is Assistant Professor in Dept. of Mechanical Engineering, P.E.S. College of Engineering, Aurangabad, MH, India

Mr. Hashmi Ayas Ahmed is Assistant Professor in Dept. of Mechanical Engineering, P.E.S. College of Engineering, Aurangabad, MH, India