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Powder mixed electric discharge machining (PMEDM) is an advanced version of ordinary electric discharge machining (EDM) process. Ordinary EDM is a non-conventional machining process in which material is removed by melting, vapourization and flushing of dielectric fluid. The application of high energy electric discharge transfers a large amount of heat to the workpiece material under the die-electric fluid medium to melt and vapourize the material from surface. This is an efficient machining process in which hard material can be easily machined with different with different peripheral shape of the machining surface. However, the major disadvantages of the process is very low material removal rate (MRR) and worse surface quality compared to other machining process.

In powder mixed EDM, electrically conductive micro powder materials have been added to dielectric fluid and a homogeneous mixture of fluid is applied before machining. During machining, the powder particles get electrically induced and start discharging along with the main spark. This process is called local discharge which removes materials additionally from every point of the surface. The removal of excess material from the workpiece helps to improve the MRR. Along with that the application of the powder particles provides uniform distribution of thermal energy in the form of local spark which improves the surface quality by reducing the roughness. The tool wear also get prevented slightly by increasing the powder particles. Nevertheless, it can be well said that the quality of the machining enhances with the application of conductive micro particles.

The EDM is classified into two types. One is die sinking EDM which is used to produce high precision dies, moulds, fixtures, tools etc. It is also used to produce an arbitrary shaped hole on the surface of difficult to machine materials. This machining is also used to manufacture surgical instruments, components of aeroplane, defence equipment and many more. Normally, the powder particles are applied on die sinking EDM for manufacturing of high precision moulding process. Along with that, PMEDM is now using for coating on hard materials and super alloys. The other type of EDM is wire EDM which has extensive use of cutting gears, cams and other components. It is also used to cut a large plate of difficult to machined material precisely and without making a large amount of waste.

In the present study, titanium and graphite micro powders have been selected as powder material and their effect have been investigated on Inconel 718, Inconel 625 and Titanium grade 2. Along with that a comparative study have been made between Inconel 718 with Titanium grade 2 and Inconel 625 with Titanium grade 2. The objectives of the present research work have been given below.

- The effects of responses have been investigated and analyzed for machining of titanium mixed EDM and graphite mixed EDM.
- The ANOVA and regression analysis have been performed to find the significant parameters and the relation of responses with process parameters respectively for both the powders.
- Mamdani based fuzzy logic and back propagation neural network have been developed and checked their acceptance for titanium mixed EDM and graphite mixed EDM respectively.
- Desirability approach based multi objective optimization has been performed to find the optimal setting of process parameters and validated with confirmatory test result.
- Surface morphology have been studied where the distribution of recast layers and measurement of width of the surface have been represented.
- Elemental analysis of titanium mixed EDM by EDX analysis and AFM study of surface roughness and XRD analysis to study the change of phase for graphite mixed EDM have been done in this experimental study.

Chapter-1 illustrates the introduction of the powder mixed EDM, types of EDM, mechanism of material removal and application of EDM.

In Chapter-2, a detailed discussion of the previous researches has been done regarding the processes, statistical methods, optimization techniques, mechanical and metallurgical characterization and elemental analysis. From the detailed literature review, it has been observed that the effects of titanium and graphite powder on two significant material i.e. Inconel and Titanium have not been analyzed earlier. Therefore, the objective of the present study based on this research gap.

Chapter-3 discusses about the materials with their compositions and properties, experimental setup, detail methodology, design of experiments, mathematical modelling, optimization techniques and characterization.

Chapter-4 represents the variation of MRR and surface roughness which have been investigated on Inconel 718 and Titanium grade 2 after the machining of titanium mixed EDM. The main effects plots, ANOVA and Regression equations have been discussed for both the results of Inconel 718 and Titanium grade 2.

In Chapter-5, the study of the effects of MRR, tool wear rate and surface roughness have been represented for Inconel 625 and Titanium grade 2.

Chapter-6 illustrates the analysis of mamdni based fuzzy logic formulated on the experimental data of Inconel 718 and backpropagation type neural network formulated on the experimental data of Inconel 625. Along with that, Desirability approach based optimization techniques have been applied for all the results and compared with the confirmatory test results.

Chapter-7 compares the surface morphological characteristics of three samples from each of the experiments. Along with that, elemental analysis for titanium mixed EDM and AFM and XRD analysis for graphite mixed EDM have been discussed.

Chapter-8 concludes the research work and discusses the future scope of the present work.

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