CERTIFICATE

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Date: _____

This is to certify that the project entitled "**Effects of machining variables on surface roughness in wire-EDM of AISI D3**" being submitted by '**Maneesh Kumar Yadav'** (College Roll No 17/E&C/09 & University Roll No- 9053) is a student of Delhi College of Engineering. This work is completed under the guidance and supervision of Dr. Vipin, (Associate Professor) in partial fulfillment of requirements for the award of the Degree of Master of Engineering (Production Engineering) in Mechanical Engineering, from University of Delhi, Delhi. He has completed his work with sincerity and diligence.

The matter embodied in this project has not been submitted for the award of any other degree

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ABSTRACT

Accompanying the development of industry, the demands for alloy materials having high hardness, toughness and impact resistance are increasing. Wire EDM machines are used to cut conductive metals of any hardness or that are difficult or impossible to cut with traditional methods. The machines also specialize in cutting complex contours or fragile geometries that would be difficult to be produced using conventional cutting methods. Machine tool industry has made exponential growth in its manufacturing capabilities in last decade but still machine tools are not utilized at their full potential. This limitation is a result of the failure to run the machine tools at their optimum operating conditions. The problem of arriving at the optimum levels of the operating parameters has attracted the attention of the researchers and practicing engineers for a very long time.

The literature survey has revealed that a little research has been conducted to obtain the optimal levels of machining parameters that yield the best machining quality in machining of difficult to machine materials like die steel AISI D3. The die steel AISI D3 is extensively used for hot-work forging, extrusion, manufacturing punching tools, mandrels, mechanical press forging die, plastic mould and die-casting dies, aircraft landing gears, helicopter rotor blades and shafts, etc. The consistent quality of parts being machined in wire electrical discharge machining is difficult because the process parameters cannot be controlled effectively. These are the biggest challenges for the researchers and practicing engineers. Manufacturers try to ascertain control factors to improve the machining quality based on their operational experiences, manuals or failed attempts. Keeping in view the applications of material AISI D3 die steel, it has been selected and has been machined on wire-cut EDM (EZEECUT PLUS WIRECUT EDM) of Electronica Machine Tools Limited.

The objective of the present work was to investigate the effects of the various WEDM process parameters on the surface roughness and to obtain the optimal sets of process parameters so that the quality of machined parts can be optimized. The working ranges and levels of the WEDM process parameters are found using one factor at a time approach. The linear regression analysis has been used to investigate the effects of the WEDM process parameters and subsequently to predict sets of optimal parameters for best surface finish.

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NOMENCLATURE

Symbol	Description
Ton	Pulse on time
Toff	Pulse off time
V_g	Spark gap set voltage
I_p	Peak current
DF, DOF	Degree of freedom
WFR	Wire feed rate
Gp	Group pulse
WEDM	Wire-electric discharge machining
AISI	American Institute of Steel and Iron
ASTM	American School of Testing Material
SAE	Society of American engineer
UNS	Unified Numbering System
CNC	Computer Numerical Control
SR	Surface roughness
Ra	Arithmetic Mean Roughness
SF	Surface Finish
DTU	Delhi Technological University
ANOVA	Analysis of variance
CWEDT	Cylindrical Wire Electrical Discharge Turning
DOE	Design of Experiment
RSM	Response Surface Methodology
WC	Tungsten Carbide
RC	Resistance–Capacitance
EES	Engineering Equation Solver
EDAX	Electro Dispersive X-ray Spectroscopy
WCS	Work Co-ordinate System
Column1	Wire feed rate (WFR)
Column2	Pulse on time (Ton)
Column3	Spark gap Voltage (Vg)
Column4	Surface Roughness (Ra)

1.6. DEFINITION OF TERMS

Accuracy – Degree of conformity to a specification.

Arc – The flow of electricity across the gap between the electrodes and the workpiece.

Arc Gap-The space between the electrode and the workpiece where EDM occurs.

Contamination – Particles and debris found in the dielectric fluid that reduces its effectiveness.

CTE– Coefficient of Thermal Expansion

Discharge – Controlled flow of current across a gap causing a spark.

Deionization – Process of removing ions.

Deionized Water – Water that has had the ions removed.

Dielectric Fluid – A liquid of low conductivity, which acts as a coolant to solidify particles and then flushes them out of the working gap.

Dielectric System – Dielectric liquid is circulated to remove contamination and control debris size in the working gap during machining. This system is composed of a pump, filter, hoses, tank, and gauges.

EDM – Acronym for Electrical Discharge Machine or Electrical Discharge Machining. EDM is a process for eroding and removing material by transient action of electric spark on electrically conductive materials.

Electrode – Electrically conductive tool used to carry current to the workpiece material.

Electrode Wear – The amount of electrode material consumed during the EDM process.

Heat Affected Zone– A shallow layer in the workpiece that has been thermally affected by the arc, which changes its properties.

Ionization – Occurs when the dielectric fluid becomes conductive after being subjected to high voltage.

Material Removal Rate– The volume of workpiece that is removed in a given unit of time (e.g., cubic inches per hour).

Parallelism – Running in the same direction in an equal and consistent manner.

Precision – Consistency of results in repeated experiments.

Pulse Generator – Creates a surge of electrical current.

RMS – Roughness is indicated by the root-mean-square (RMS) average, which is the square root of the average value squared, of a series of measurements of deviations from the roughness centerline.

Speed – The advance rate of the workpiece perpendicular to the wire, measured in inches per minute.

Tab- A small insert, addition, or remnant; Web

Tensile Strength– The maximum engineering stress in tension, which may be sustained without fracture; often termed ultimate (tensile) strength.

Thermal Conductivity–For steady-state heat flow, the proportionality constant between the heat flux and the temperature gradient. Also, a parameter characterizing the ability of a material to conduct heat.

Tolerance – The permissible deviation from an ideal.

WEDM – An EDM process wherein the electrode is a wire that cuts through the workpiece and is renewed constantly to avoid rupture.

Working Gap – The gap between the electrode and the workpiece