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# Review Paper on Optimization of Metal Inert Gas Welding on Stainless Steel AISI 410by Taguchi Method

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***Abstract: Austenitic stainless steel is widely used materials in the current industrial area including higher and lower temperature applications such as storage tanks, pressure cups, furnace equipment etc. Using ratio of those materials are increasing constantly due to having superior corrosion resistance and mechanical properties, GTAW process are widely used for stainless steel welding, especially for full penetration welds in thin gage materials. Selection of shielding gas and filler material is crucial parameter for the quality, the micro structure and properties of weldments. The weldment properties strongly depended on the shielding gas, since it dominates the mode of metal transfer. Shielding gas not only affects the properties of weld but also determines weldability, the appearance, the shape and penetration of bead as well. Pure argon is mainly used for GTAW as shielding gas at present. The most common shielding gases are argon riches mixtures, such as argon with a few percent helium, carbon dioxide, hydrogen, oxygen, nitrogen for GTAW process. In this project we will be made many attempts for made test pieces(SS410) to predict the process parameter of MIG for getting maximum weldment, best mechanical properties and min HAZ. The planned experiments are conducted in the MIG are welding machine; the test piece examination is carried out by following process***

## I. INTRODUCTION

### *A. Welding Over View*

Welding is the process of fusing two materials together using extreme heat, pressure and (or) fillers. Welding processes have developed to fit every industrial need imaginable. The two types of welding most prevalently in use are Arc welding Gas Arc welding.

### *B. Types of Welding*

*1)* Arc welding
*2)* Gas welding
*a)* MIG welding
*b)* TIG welding

### *C. ARC Welding*

Arc welding is a process utilizing the concentrated heat of an electric arc to join metal by fusion of the parent metal and the addition of metal to joint provided by a consumable electrode. Either direct or alternating current may be used for the arc, depending upon the material to be welded and the electrode used. A welding power supply is used to create and maintain an electric arc between an electrode and the base materials to melt metals at the welding point. In such as welding processes the power supply could be AC or DC, the electrode could be consumable or non-consumable and a filler materials may or may not be added. The most common types of arc welding are:

## II. LITERATURE SURVEY

IzzatulAini Ibrahim,[1] (2013) et.al were analyzed GMAW process is leading in the development in arc welding process which is higher productivity and good in quality. They were studied, the effects of different parameters on welding penetration, microstructural and hardness measurement in mild steel that having the 6mm thickness of base metal by using the robotic gas metal arc welding are investigated.

The variables that choose in this study are arc voltage, welding current and welding speed. The arc voltage and welding current were chosen as 22, 26 and 30 V and 90, 150 and 210 A respectively. The welding speed was chosen as 20, 40 and 60 cm/min. The penetration, microstructure and hardness were measured for each specimen after the welding process and the effect of it was studied.

D.S. Yawas,[2] (2017) et.al were investigated fatigue behavior of welded austenitic stainless steel in 0.5 M hydrochloric acid and wet steam corrosive media has been investigated. The immersion time in the corrosive media was 30 days to simulate the effect on stainless steel structures/equipment in offshore and food processing applications and thereafter annealing heat treatment was carried out on the samples. The findings from the fatigue tests show that seawater specimens have a lower fatigue stress of 0.5 _ 10_5 N/mm2 for the heat treated sample and 0.1 _ 10_5 N/mm2 for the unheated-treated sample compared to the corresponding hydrochloric acid and steam samples.

M.N.Chougule et.al[3](2019) were carried out Gas metal arc welding (GMAW) controls the metal from the wire rod by developing the arc as well as by controlling the input process parameters. High heating at a one location during welding and further rapid cooling generates residual stress and distortion in the weld and base metal. In the last few decades, various research efforts have been directed towards the control of welding process parameter aiming at reducing residual stress and distortion they are strongly affected by many parameters like structural, material and welding parameters. Such welding failure can be minimized by controlling the weld heat input. The distribution of the temperature in weld joint of AISI202 grade high strength steel is investigated by Finite Element Method (FEM) using ANSYS software and experiment has been performed to verify the developed thermo-mechanical finite element model using the GMAW process.

LI YAJIANG[4] (2020)et.al were experimentally analyzed distribution of the residual stress in the weld joint of HQ130 grade high strength steel was investigated by means of finite element method (FEM) using ANSYS software. Welding was carried out using gas shielded arc welding with a heat input of 16 kJ/cm. The FEM analysis on the weld joint reveals that there is a stress gradient around the fusion zone of weld joint. The instantaneous residual stress on the weld surface goes up to 800 ~ 1000 MPa and it is 500 ~ 600 MPa, below the weld. The stress gradient near the fusion zone is higher than any other location in the surrounding area. This is attributed as one of the significant reasons for the development of cold cracks at the fusion zone in the high strength steel. In order to avoid such welding cracks, the thermal stress in the weld joint has to be minimized by controlling the weld heat input.

Q.Wang[5] (2013) et.al were carried out influences of parameters of tungsten inert gas arc welding on the morphology, microstructure, tensile property and fracture of welded joints of Ni-base super alloy have been studied. Results show that the increase of welding current and the decrease of welding speed bring about the large amount of heat input in the welding pool and the enlargement of width and deepness of the welding pool. The increase of impulse frequency has the same effect on the microstructure compared with the increase of welding current. The effect of welding parameters on the tensile strength and fracture was analyzed.

G. Magudeeswaran[6] (2009)were studied activated TIG (ATIG) welding process mainly focuses on increasing the depth of penetration and the reduction in the width of weld bead has not been paid much attention. The shape of a weld in terms of its width-to-depth ratio known as aspect ratio has a marked influence on its solidification cracking tendency. The major influencing ATIG welding parameters, such as electrode gap, travel speed, current and voltage, that aid in controlling the aspect ratio of DSS joints, must be optimized to obtain desirable aspect ratio for DSS joints. Hence in this study, the above parameters of ATIG welding for aspect ratio of ASTM/UNS S32205 DSS welds are optimized by using Taguchi orthogonal array (OA) experimental design and other statistical tools such as Analysis of Variance (ANOVA) and Pooled ANOVA techniques. The optimum process parameters are found to be 1 mm electrode gap, 130 mm/min travel speed, 140 A current and 12 V voltage.

Fanrong Kong [7] (2011) et.al were investigated a model based on a double-ellipsoidal volume heat source to simulate the gas metal arc welding (GMAW) heat input and a cylindrical volume heat source to simulate the laser beam heat input was developed to predict the temperature field and thermally induced residual stress in the hybrid laser–gas metal arc (GMA) welding process. Numerical simulation shows that higher residual stress is distributed in the weld bead and surrounding heat-affected zone (HAZ). Effects of the welding speed on the isotherms and residual stress of the welded joint are also studied. It is found that an increase in welding speed can reduce the residual stress concentration in the as-weld specimen. A series of experiments has been performed to verify the developed thermo-mechanical finite element model (FEM), and a qualitative agreement of residual stress distribution and weld geometrical size is shown to exist.

N. Akkuş [8] (2013) et.al were studied is to realize a simulation of arc welding using Finite Elements Analysis (FEA). In general, thin steel metals are used in the automotive and machine industries and the distortion after arc welding is more evident, because of the lack of quality in the product this creates problems. It is important to predetermine these problems before welding process.

One way of the prediction of welding process is “try and see”. But this may need high cost and time. Therefore, Finite Element Method is very often used today to monitor and predict the welding process. In order to do this, MSC.Marc-Mentat program was used to simulate the arc welding process by 3-D modeling in terms of temperature distribution and distortions. Then, the results of experiments were compared to that of obtained in the simulation. The comparison of the results revealed familiarity between the presented FE model and experiments

J. Dutta[9] (2018) et .al were investigated reveals an elaborate analysis of variation of thermal properties of high carbon steel plate butt joints formed by DC Gas Tungsten Arc (GTA) welding. Experiment has conducted to predict the two dimensional temperature cycle developed. To find out the heat flux distribution, Gaussian Heat source model has been implemented. Carslaw-Jaeger’s mathematical model has been incorporated to estimate the variation of thermal conductivity. To portray the change in specific heat at different locations from the fusion boundary at experimental temperatures, Thin plate model has been utilized. Heat loss due to convection, radiation and evaporation have been studied. To estimate total heat loss from weld joint at different locations a method has been proposed and Vinokurov’ s empirical correlation has been used for validation. At very close region (36mm from fusion boundary) to heat affected zone all thermal properties have shown significant variation based on experimental results. From the analysis of heat loss an optimum temperature has been observed and it is helpful to define the range of convection and radiation heat loss phenomena.

R.Ahmad [10](2020) et.al were studied the effect of a post-weld heat treatment (PWHT) on the mechanical and microstructure properties of an AA6061 sample welded using the gas metal arc welding (GMAW) cold metal transfer (CMT) method. The CMT method was used because the method provides spatter-free welding, outstanding gap bridging properties, low heat input and a high degree of process flexibility. The welded samples were divided into as-welded and PWHT samples. The PWHTs used on the samples were solution heat treatment, water quenching and artificial aging. Both welded samples were cut according to the ASTM E8M-04 standard to obtain the tensile strength and the elongation of the joints. The failure pattern of the tensile tested specimens was analysed using scanning electron microscopy (SEM). A Vickers micro hardness testing machine was used to measure the hardness across the joints. From the results, the PWHTs were able to enhance the mechanical properties and microstructure characteristics of the AA6061 joints welded by the GMAW CMT method.

Faiz.F [11](2009).,Automated Manufacturing Engineering Department, Al-Khwarizmi College of Engineering, University Of Baghdad, Baghdad, Iraq Dec 2016 Gas metal arc welding (GMAW) or as called metal inert gas (MIG) is used for welding pipeline, which is a semi-automatic arc welding process. Machine that hold and carry the welding gun of the MIG machine moving on a circular rail fixed near the pipe groove, can helpfully to improve the welding finish compared with the manual process by maintaining in parameters of welding such as keep the distance between the gun and the groove of weld joint, constant travel speed of the welding gun, also saving in time and funds. Many advantages such as maintain the health of workers, reduced in errors and troubles that occur during the welding process.

Khalid Abbasi [12](2018),, In this study the effect of MIG welding parameters on the weld bead and shape factor characteristic of bright drawn mild steel specimen of dimensions 144 31 10 mm has been investigated. The welding current, arc voltage, welding speed, heat input rate are chosen as welding parameters. The depth of penetration and weld width were measured for each specimen after the welding operation and effect of welding speed and heat input rate parameters on depth of penetration and weld width were investigated. The present paper aims at the evaluation of depth of penetration and weld width by employing different MIG welding parameters.

Rajat Malik [13](2016),, Welding is defined as one of the most efficient manufacturing and fabrication processes which exist in the category of formation of permanent metal to metal joints used widely in industries and production applications. The basic difference between conventional MIG welding and synergic MIG welding is that in synergic MIG welding, each pulse is responsible for the detachment of unit liquid metal into the puddle. Synergic MIG welding is in category of pulse-type MIG welding. A synergic MIG welding setup is designed to be a spatter less welding process that will consume lower-power heat consumption than spray or globular processes. An arc formation occurs between wire metal electrode and workpiece resulting the melting of metals at higher temperature

Sachin H Patel [14](2020) ,, In this study Metal inert gas (MIG) welding also known as Gas Metal Arc Welding (GMAW) process consists of heating, melting and solidification of parent metals and a filler material in localized fusion zone by a transient heat source to form a joint between the parent metals. A consumable electrode is used which also plays the role of conductor. MIG welding gives little loss of material and can be operated as semi as well as fully automated.

The current work aims to study the effects of parameters in gas metal arc welding of AISI 1020 material. 10 mm thick AISI 1020 material plates are used as work material to be welded by gas metal arc welding process Detailed experiments are designed and performed on the basis of orthogonal array (OA) and welding strength measured and analyzed using trend graphs. An optimum combination of process parameters, finds out by Taguchi method. Optimization result has been used for identifying the most significant parameter effect on welding strength.

Gaurav V. Patel [15] (2010),, Welding is widely used by manufacturing engineers and production personnel to quickly and effectively set up manufacturing processes for new products. The MIG welding parameters are the most important factors affecting the quality, productivity and cost of welding. This paper presents the influence of welding parameters like welding current, welding voltage, Gas flow rate, wire feed rate, etc. on weld strength, ultimate tensile strength, and hardness of weld joint, weld pool geometry of various metal material during welding. By using DOE method, the parameters can be optimize and having the best parameters combination for target quality. The analysis from DOE method can give the significance of the parameters as it give effect to change of the quality and strength of product.

Shusan Zhao [16] (2011),, In this paper, three methods of adding and activating weld bead elements, i.e., adding and activating the weld bead segment by segment (case A), adding and activating one weld pass after another (case B), and modified adding and activating one weld pass after another (case C), were employed to establish the corresponding simulation model of a butt joint of AA6061-T6 mid-thick plate with a double-pass weld by ABAQUS. The welding temperature field, residual stress field, and welding deformation were simulated. The heat loss of three methods in the welding simulation was tested by theoretical calculation. To verify the simulation results, the metal-inert gas (MIG) welding experiment was also performed, and the molten pool dimensions, residual stress, and welding deformation were measured. The results show both cases A and C can be effectively employed to predict residual stress, and case C can also save computing time. Case A can more accurately predict the welding deformation.

S. R. Patil, C. A. Waghmare [17] (2020) ,, This paper presents the influence of welding parameters like welding current, welding voltage, welding speed on ultimate tensile strength (UTS) of AISI 1030 mild steel material during welding. A plan of experiments based on Taguchi technique has been used. An Orthogonal array, signal to noise (S/N) ratio and analysis of variance (ANOVA) are employed to study the welding characteristics of material & optimize the welding parameters. The result computed is in form of contribution from each parameter, through which optimal parameters are identified for maximum tensile strength. From this study, it is observed that welding current and welding speed are major parameters which influence on the tensile strength of welded joint.

G. Arun kumar , M.Harsha [18] (2016),, An attempt has been made in this paper to weld SS410 alloy using GTAW and GMAW with argon as a shielding gas. MIG is a welding process in which an electric arc forms between a consumable wire. Electrode and the work piece which heats the metal(s) causing them to melt and join. It is preferred over other fabrication process because of its higher deposition rates, higher welding speed and positional welding offers no problems. Mechanical properties (joint strength, hardness variation along weld joint) and microstructures (Grain sizes, material composition) were analyzed to study the behavior of ss410 material for three different weld butt joint configurations. i.e V-60o ,V-90o and X-60o .

D. Yappa [19]2014,, was investigated on Optimization procedures for GMAW of bimetal pipes. Autogenous gas tungsten arc welding (GTAW) and pulse rapid arc gas metal arc welding (GMAW) of butting bimetal (Bubi) pipelines were studied. GMAW was carried out from the outside of the pipe while GTAW was done from the inside to prevent lack of penetration and to promote a smooth internal weld bead surface

PRIYANKA CHAUDHARY, Mr. ABHISHEK SRIVASTAV [20] (2020),, In the futuristic epoch, in metal merge industries, the prerequisite of the metal merge is to manufacture preferable surface hardness and remarkable quality welds. The MIG welding machine is esoteric in merge complex shapes with remarkable various exemplar and check their hardness using Rockwell hardness tester and surface quality using the SEM. For the analysis of the data I used taguchi approach. After this I performed a confirmation test to justify our calculated result. The experimental results concluded that hardness is mainly factors by welding voltage followed by welding current and least by welding speed. In the case of surface quality, it was found that each parameter has greater influence on the quality of surface produced. The size of work piece 130*50*5 mm

Dr. S V Anil Kumar [21] (2020),, The present review paper, study the effect of different process parameters such as welding current, voltage, gas flow rate, welding speed and gas pressure on mechanical properties like tensile strength and percentage of elongation of MIG welded joints of SS410 mild/low carbon steel plates. MIG welding is a high deposition rate welding process in which wire is continuous feed from a gun or spool. MIG welding offers several advantages like all position capable, long weld can be made, no slag etc. Optimization was done to find optimum welding conditions to maximize tensile strength and percentage elongation of welded joints.

The confirmation test was also conducted to validate the optimum parameters settings. From the review papers study, it is found that when the welding current, voltage, Gas Flow Rate increased, the tensile strength decreases, but when welding speed increases, the tensile strength also increases for SS410 steel weld joint. SS410 is non-hardenable ductile steel belonging to low carbon steel categories. It has been widely used for machining applications like machine parts, rod, bolts, studs etc. It shows that good weld ability and also used for carburized parts.

HarshKumar Patel [22] (2018),,MIG welding is widely used technique in different areas. For the strength point of view there is groove welding which is also very popular. In this study, important process parameters namely welding current, gas flow rate, gas proportion, feed rate and weldingspeedkept constant throughout. Experiments are conducted on specimens of single-v butt welded joint, material selected for preparing the test specimen is IS2062 E250 grade. The ultimate tensile strength of the welded joint is tested by a universal testing machine and the results are evaluated.

Prasenjit Mondal [23] (2015),, Dissimilar metal welded joints are integral parts of modern-day power and process plant equipment. Among the various types of material combinations, welded joints of austenitic stainless steels and mild steel are very common in nuclear and chemical industries. The dissimilar metal joints have been emerged as a structural material for various industrial applications which provides good combination of mechanical properties like strength, corrosion resistance with lower cost. Selections of joining process for such materials are difficult because of their physical and chemical properties. Dissimilar material joints of stainless steel and mild steel are commonly uses as structural applications. Joining of stainless steel and mild steel is very critical because of carbon precipitation and loss of chromium leads to increase in porosity which affects the quality of joint leads deteriorates strength. Shielding gases are necessary in GMAW process to protect the welding area from atmospheric gases such as nitrogen and oxygen, which can cause fusion defects, porosity and weld metal embitterment. In the present study, stainless steel plate of SS410 has been welded with mild steel plate of IS: 1079 by Metal Inert Gas (MIG) welding processes. The tensile strength and hardness of dissimilar metal joints have investigated. The results were compared for different joints made by MIG welding processes and finally optimize the best combination of input parameters.

H.R. Ghazvinloo , A. Honarbakhsh-Raouf [24] (2010),, have a wide range of desirable properties which are used in different industries such as aircraft industry and other aerospace structures. The effect of process parameters on fatigue life and impact energy of weld metal, and bead penetration in AA6061 joints produced by MIG robotic welding was studied in this paper. Different samples were produced by employing arc voltage of 20, 23, and 26 V, welding current of 110, 130, and 150 A, and welding speed of 50, 60, and 70 cm/min. After welding operations, the mechanical properties of the weld metal were evaluated by fatigue and impact testing at room temperature, and bead penetration was measured for geometrical specimens. Results were clearly illustrated when heat input increases, fatigue life of weld metal decreases whereas impact energy of weld metal increases in first and then drops significantly. The largest penetration in this study was observed for 60 cm/min welding speed..

## III. CONCLUSION

From the obtained literature review, it was found the following conclusion: -

Many attempts have made for stainless steel to predict the process parameter by Welding like TIG and Mig for getting the maximum weldment and good weld deposition best mechanical properties and min HAZ. The planned experiments were conducted in the MIG and TIG welding machine with researcher's; the test piece examination were carried out by following process.

1) Hardness testing
2) Bead Geometry measurements.
3) Impact testing.
4) Ultrasonic test testing.

Also, the literature revived that the different and suitable input parameter were studied.

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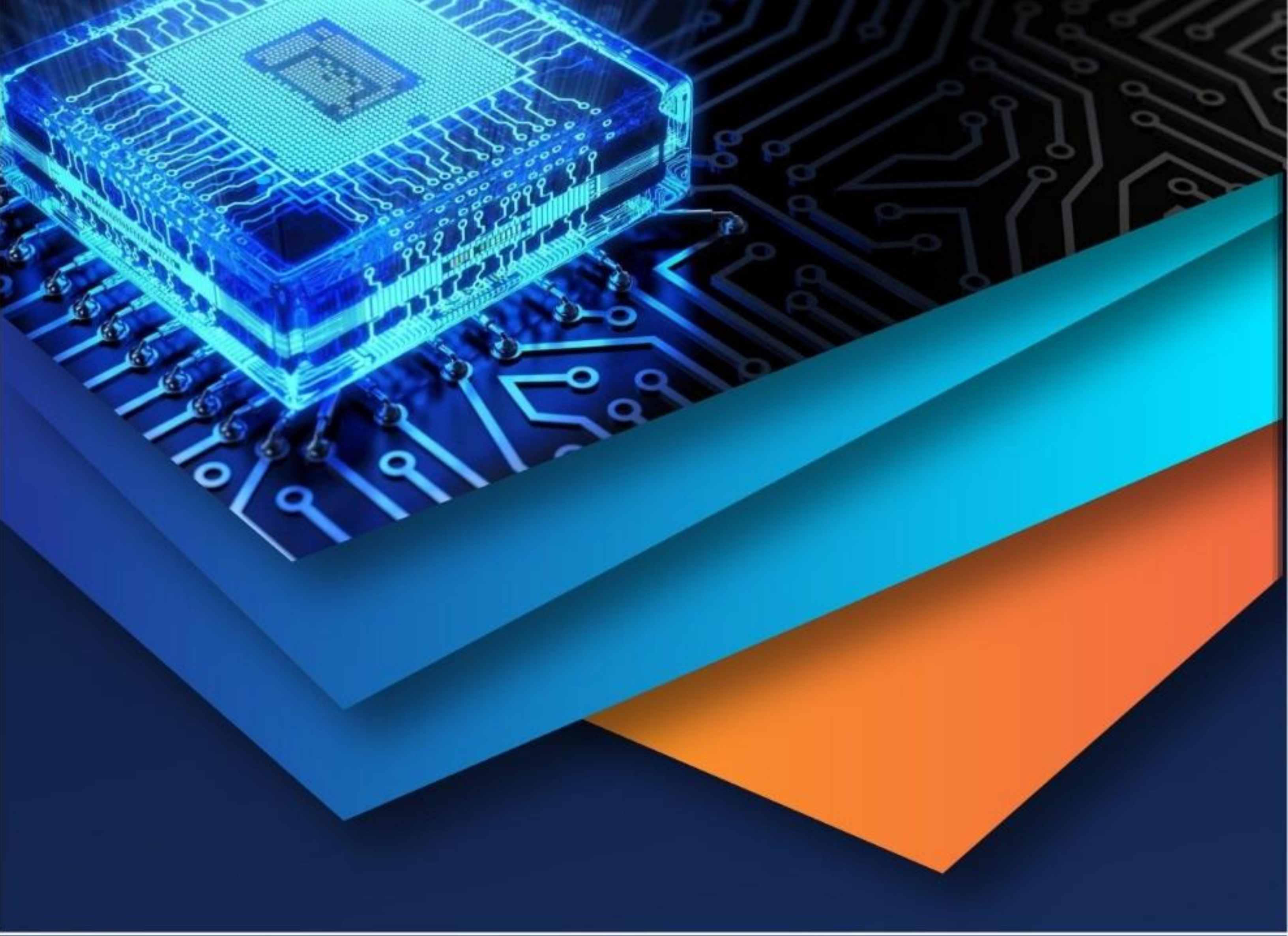


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