# A review on optimization of drilling process parameters of AISI 304 austenite stainless steel by using response surface methodology

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***Abstract* - In today's competitive environment application of optimization techniques are very useful for maintaining and improving both the aspect of manufacturing such as quality and productivity. In this paper an attempt is made to give an overview on the optimization of different parameters in drilling process through literature review. The response surface methodology and design of experiments techniques are being extensively used in the current & past research works on drilling process. There are different factors like cutting speed , feed rate and drill point angle, cutting conditions, material type, etc. which could affect the quality of product during machining operation. The researchers in the following literature review have worked on drilling AISI 304 steel by taking into consideration the above mentioned factors.**

***Index Terms* - Drilling, Response surface methodology, Design of experiments, Optimization**

## I. INTRODUCTION

Drilling operation is the most commonly used machining operation that uses multipoint cutting tool called drill or drill bit to remove unwanted material for producing or enlarging desire hole. The main focused of modern machining industries on achievement of high quality, in term of work piece drilled accuracy and surface finish. Surface finish is concerned with the geometrical irregularities on the surface of material. Surface roughness is the one of the crucial performance parameter that has an appreciable effect on mechanical properties of finished parts such as creep life, fatigue behavior and corrosion resistance, etc. The geometry of cutting tool, work materials, and parameters like cutting speed and feed directly affects drill performance. These parameters should be selected to optimize the drilling operation. So it can be achieved by function of drilling conditions using design of experiments (DOE). An optimization is carried out on proposed work with the help of response surface methodology for maximum metal removal rate, minimum surface roughness and minimum hole diameter error.

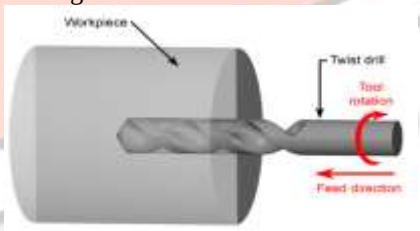


Fig. Basic drilling operation

## II.NEED FOR OPTIMIZATION

Industries and applications that require large production, the drilling time and finishing of holes rivals the cost of process. So an intensive study of machining process is required to make the production economical. Machining of AISI 304 austenitic stainless steel is critical due to its supreme properties like high wear resistance, high toughness, low thermal conductivity and high tensile strength. In traditional approach the selection of cutting condition for machining is left to the machine operator. In this condition the experience of the machine operator plays a vital role, but even for a highly skilled operator it is difficult to attain the desired quality output values every time by considering the parameters values on the basis of his knowledge. Nowadays, many industries are interested in optimizing machining process in order to improve quality reduce cost, & for obtaining high efficiency. To achieve this conditions, analysis of data during manufacturing is needed to be carried out by using suitable optimization techniques.

## III. METHODOLOGY

To optimize the different drilling process parameters design of experimentation and response surface methodology techniques are used.

### A) Factors Involved

While performing the experimentation there are certain factors needed that should be taken care which are, factors related to the machine, drilling tools, drilling conditions & work material. Cutting speed, feed rate and drill point angles are said to be the input

parameters which can be controlled by changing its values. The other factors which need to be considered are the output factors such as surface roughness and material removal rate. The input machining factors if studied properly through experimentation can lead to achieve desired values of the output factors mentioned above

**B) Design of the Experiment**

There are various techniques available from the statistical theory of experimental design which is well suited to Engineering investigations. One such important technique is a Response Surface Technique for studying the effect of parameters on response and this is one which was selected for the experiment. The design of experiment is the procedure of selecting the number of trails and conditions for running them, essential and sufficient for solving the problem that has been set with the required precision.

**C) Response Surface Methodology**

RSM is an experimental tool invented to solve the optimal response within specified range of factors. In order to improve the process quality attention was given & methodology was carried out by using experimental design, specifically for minimizing the variation in output response of a product or process around a target value and to design product & processes so that they are robust to environment condition. By careful design of experiments, the objective is to optimize a response variables (output variable) which are affected by several independent variables (input variables).

## IV. LITERATURE REVIEW

**Arshad Noor Siddiquee et.al (1)**, carried out the work to study the effects of control parameters on surface roughness. They uses design of experiments and orthogonal array to find range and combinations of drilling parameters like cutting fluid, speed, feed and hole-depth, to achieve optimal settings of output response variables like surface roughness in drilling operation of AISI 321 Stainless Steel material. Four parameters namely cutting fluid, speed, feed and hole depth are varied to study their effect on surface roughness. The parameters considered in the experiments are optimized to attain minimize the surface roughness. They carried work on CNC lathe with K- series Solid carbide drill having 10mm diameter as a tool material. Work is carried out on Minitab and ANOVA software for effect analysis. They selected L18 orthogonal array. Taguchi design offers systematic and efficient approach and can decrease number of experiment to optimize the process parameters, quality and manufacturing cost. The best setting of input process parameters for minimize surface roughness within selected range is as: 1)Cutting fluid-present, 20)speed-500 r.p.m., 3)feed rate-0.04mm/s and 4)hole-depth-25mm. The improvement of surface roughness from starting cutting parameter to the optimum cutting parameters is about 131%.

**Ferit Ficici et.al(2),** in this study the performance of input parameters on Surface roughness in drilling of 304 stainless steel was studied. The drilling tests were carried out to determine the roughness under various drilling conditions. Modified HSS drill with 10 mm diameter used as tool for experimental investigations. Optimization of surface roughness is solved by using Taguchi method. They selected L27 array for taguchi design.. They concluded that modification of drill bit and feed were the most important factors on the surface roughness (Ra). The optimal results of the surface roughness (Ra) were obtained at lower feed rate and higher drilling speeds by using 0.5 μm drill. Statistical results show that the drill modification condition, cutting speed and feed rate influence the surface roughness in the drilling process by 74.25%, 13.72%, and 6.25%, respectively.

**Dayal Saran P et.al (3)**,made effort to find out effects of control factors in radial drilling. They conducted an experiment according to design matrix by using radial drilling machine. Different cutting parameters namely drill bit diameter, cutting speed, and feed rate are used for the optimal setting of the parameters on radial drilling of brass. High Speed Steel drill bits are chosen as a tool for drilling. Machining has been done as per the Design Matrix, Box-Behnken design was used to decide the number of experiments to be performed. The effect of drilling parameters on surface roughness was evaluated and optimal setting were determined for minimization of surface roughness. Response Surface Methodology is used to determine true mean response and input control variables affecting the response as a two or three dimensional surface. The adequacy of the developed model is checked using ANOVA at 95% confidence level at found to be adequate. The optimization results showed that the surface finish of the drilled hole decreases with drill speed, drill feed rate and from dry condition to wet condition. However by increasing the drill diameter surface finish value increases.

**Mr. Dhanke V. D et al (4)**, in this study they selected AISI 1015 as a workpiece material. The purpose of this study is to optimize the input parameters for minimizing burr size by using taguchi and RSM method. Speed , feed , drill diameter and point angle was selected as input parameter and burr height and burr thickness was selected as a response variable. For experimental design Central composite Design was used. Experiment was carried out on CNC machining centre HASS VF2SS with maximum speed, 12000 r.p.m. The measured result were analyzed with the help of MINITAB software. Minimum burr height obtained at 28m/min cutting speed,0.1 mm/rev feed rate, 20mm drill diameter and 135° degree point angle and minimum burr thickness obtained at 16m/min cutting speed, 0.5 mm/rev feed rate, 4mm drill diameter and 142° point angle.

**Yogendra Tyagi et al (5)**, focused on performance of input parameters on metal removal rate and surface finish. They performed drilling operation on mild steel with the help of cnc drilling machine. Cutting speed, depth of cut and feed rate were considered as input control factor. The optimum value of machining parameters was selected to minimize surface roughness and maximize metal removal rate. They selected L9 orthogonal array for taguchi design. Experimental Data was collected and analysed.. The predicted optimum parameter setting after completion of experiment was found to be 1.46 cm3/min metal removal rate and 2.12 (Ra) surface roughness.

**Sudesh Garg et. Al (6)** were performed an experiment on CNC MILL MT250 Machining Center on AISI H11 steel. Different driing parameters like speed, feed rate and hole depth were used for the optimal setting of the parameters on drilling AISI H11 steel. The effect of drilling parameters on metal removal rate was evaluated and optimal setting conditions were determined for maximization of MRR using face centered design. Experimental trials were based on design of experiment and followed by optimization using ANOVA. 20 experiments were performed according to response surface methodology based on face centered design. Tungsten carbide high speed core drills having 10 mm diameter with two flute was used as a tool for experimentation. They concluded from the result of ANOVA that as spindle speed and feed rate increases the metal removal rate also increases and hole depth dose not cause any significantly affects on metal removal rate. The maximum value of metal removal rate1484.75 mm3/min obtained at cutting speed of 1200 rpm and feed rate at 0.02 mm/rev.

**Murthy B.R et.al (7),** worked is carried out on Glass Fibre Reinforced Polymer (GFRP) composite material. They selected drill diameter, spindle speed, drill point angle, feed, and material thickness, as input process parameters and thrust force and torque as output parameter. The effect of parameters such as spindle speed, drill diameter, feed rate, drill point angle and material thickness and some of their interactions were evaluated using ANOVA. The experimentation was performed on TRIAC CNC vertical machining centre. Thrust force generated during drilling operation and measured with the help dynamometer. They concluded that thrust force was affected by spindle speed and they are inversely proportional. Cutting torque was significantly influenced by drill diameter. cutting torque and thrust force both increase with the increase in material thickness and feed rate.

**Mr.Nalawde P.S et.al (8),** effort had been taken to Optimize Surface Finish and Hole Accuracy in Drilling operation. They performed experiment on EN-31 material. Speed, type of tool, feed, and depth of cut was selected as a input parameter. The effect of drilling parameters on surface finish and hole accuracy were investigated in drilling of EN-31 material with different HSS twist drill. In this work drilling operation performed using 10 mm diameter HSS TiN-coated drills, HSS TiAlN-coated drills, HSS twist uncoated drills. Smaller is better was selected as optimization of setting of parameter for achieving higher surface finish. Experimental trials shown the result based on L9 orthogonal array. Several input parameters had been taken depending upon orthogonal arrays. This study investigate the effects of input parameters by the application of taguchi method on surface finish and hole accuracy in dry drilling of EN-31 material. For surface finish optimum value of cutting speed was 30 m/min Feed ( 0.2 mm/min) and Type of Tool was HSS uncoated twist drill. For hole accuracy optimum values obtained from analysis was cutting speed ( 30 m/min), Feed (0.2mm /min) and type of tool was (HSS+ TIN) coated drill.

**Adem Cicek et.al (9)**, worked to find out effects of parameters on surface roughness and roundness error. In this study experiment were carried out on AISI 316 stainless steel. The effects of deep cryogenic treatment and drilling conditions were evaluated in drilling 316 stainless steel with M35 HSS twist drill as a tool. L8 orthogonal array was used for experimental trial. The surface roughness of hole was measured by using Mitutoyo surfest SJ-301 roughness tester. Mitutoyo CRT-A C544 three dimensional CMM device was used for measurement of roundness error. Feed, different cutting tools and cutting speed were used as a input parameters. The optimum level of parameters were obtained by evaluating the control factors generated by orthogonal array. From the given analysis it was found that surface roughness and roundness error were minimum with a treated drill at feed rate of 0.08 mm/rev feed rate and cutting speed of 14 m/min. Optimum values of roundness error and surface roughness were found as 5.60 μm and 1.77 μm.

**J.Pradeep Kumar et.al (10),** worked to investigate the influence of drilling parameters on tool wear, material removal rate, hole diameter error and surface roughness in drilling of OHNS material. Tool used was HSS spiral drill bit. Commercial available software MINITAB 13 was used to analysed the effect. 18 number of experimental trials has been conducted on material. From this study it is found that speed and feed are the most important factor that effects the output response characteristics.

## V.CONCLUSION

By reviewing all the research papers, we finally come to the conclusion that there are many research done on optimization techniques for process parameter for material removal rate and surface roughness. But we found that there are very few research done on drilling process parameter for AISI 304 stainless steel. So we want to do research on this particular material. We like to use Response surface methodology for optimization. In this research work we want to investigate influences of input parameters like cutting speed, feed rate and drill point angle on response parameters like material removal rate and surface roughness. By using proper optimization Techniques and efficient software like (Minitab, ANOVA), we can obtain optimum output response parameters such as surface roughness, metal removal rate etc.

## VI. FUTURE SCOPE

The above mentioned researchers had successfully conduct the experiment and reached to the desired outputs The control parameters, optimization techniques, analysis software's taken into consideration by these researchers can help the new researchers and students willing to carry out experimentation on the drilling process.

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