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Optimization of Machining Parameters on End Milling of Steel Grade EN 8: A Review

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Abstract

Nowadays, most of the machining industries are facing a challenge to achieve high quality of product at given time and reasonable price according to customer requirement. The optimization of machining parameters of manufacturing process leads to effective as well as efficient manufacturing. End milling is one of the operations of milling process, which is used to cut horizontal, vertical and inclined profile. So, generated key ways or profile should be accurate in terms of surface roughness as well as dimensional accuracy. The study investigates optimization of end milling process by optimization of its machining parameters for improving surface roughness and material removal rate.

Keywords: *End mill, surface roughness, MMR, parameters optimization, design of experiments*

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INTRODUCTION

Most of the industries carry out machining process for manufacturing, and now days, majority industries use manufacturing process which have advanced technology in order to get effective and efficient output with economy.

End milling is one of the manufacturing processes used in multipoint cutting tool to produce horizontal, vertical, and inclined profile. End mill operation and the end mill advance at angle with rotary motion.

End milling is widely used in variety of manufacturing industries including aerospace and automotive sectors, where quality is important in factors as the production of slots, pockets, precision moulds, and dies because good quality of milled surface significantly affects fatigue strength, corrosion resistance and creep life.

End milling operation is done on vertical milling centre by using cutting speed, feed rate, and depth of cut as input parameters irrespective to get output namely good surface roughness, maximum MMR, minimum surface roughness, minimum tool wear rate and increasing productivity.

In order to get efficient and effective output, optimization of above mentioned machining parameters is required. Optimization of machining process parameters is done by use of DOE. This gives optimum values of input parameters which are significantly affected on output parameters. Figure 1 shows the end milling setup.

LITERATURE REVIEW

Literature review is an important part of any review or research paper for understanding:

1. The important aspects of work;
2. A data source that work used;
3. Ideas for further consideration, etc.

Here is the summary of work or experiments for brief understanding of process parameters of end milling operation with details of papers published and input-output parameters studied by some authors.

End milling process is generally used to produce key way and profile on components accurate to customer's requirement. Various researches have been carried out on end milling process and explained various types of experimental and mathematical techniques.

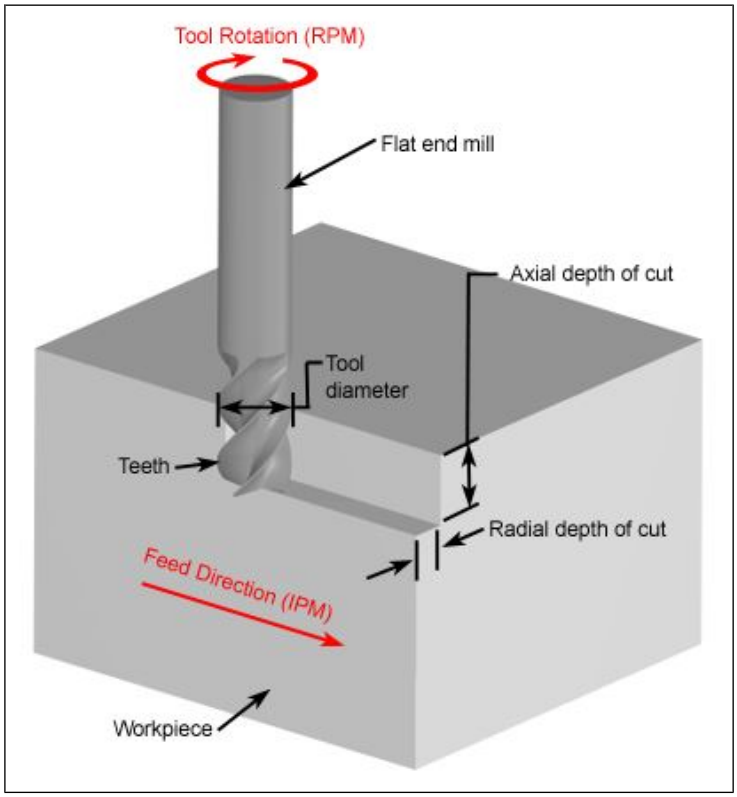

Fig.1: *End Milling Setup.*

Parashar and Purohit researched on end milling process on a vertical milling machine SV-2E, considering machining parameters' optimization in order to improve surface roughness and MMR by using taguchi method of DOE [1]. Mia researched on end milling parameters under through-tool cryogenic cooling condition and dealt with quality characteristics such as cutting force, surface roughness and specific cutting energy in milling of hardened steel by use of mathematical modeling and optimization by using RSM, full factorial based DOE was also used which focused on input variables cutting speed, feed rate etc. [2]. Riberio *et al*. researched on end milling for improving surface quality and concluded that radial cutting depth and the interaction between radial cutting depth and axial cutting depth lead to the minimization of surface roughness by using taguchi and ANOVA techniques [3]. Masmiati *et al*. researches on end milling of S50C medium carbon steel for minimum residual stress cutting force and surface roughness. Thermal and mechanical loading similarly affect the behavior of residual stresses. Therefore, this research focused on effect of milling mode and DOC respectively on output parameters using mathematical modeling and RSM techniques [4]. Durakbasa *et al.* researched on end milling parameters of AISI H13 steel by using precise and fast measurement and especially focused on effect of tip radius of the tools on the machined surface quality with modern and precise measurement techniques and method. Taguchi for DOE method was used to determine the optimum processing parameters [5]. Vopat *et al.* researched on influence of different types of copy milling on the surface roughness and tool life of end mills. The research focused on different tool life of samples according to type of copy milling. Tool life of sample for down-copying is longer than for up copying. Cutting tools in up copying showed lower values of surface roughness [6]. Nair *et al*. researched on comparison between different optimization techniques for CNC end milling process. Different techniques used like taguchi, grey analysis, PCA, TOPSIS and concluded that last three techniques gives same results [7]. Campatell *et al.* researched on minimizing power consumption in the milling of carbon steel. This research work focused on the

efficiency of machining centers and provided experimental analysis by using RSM in order to minimize the power consumption in milling process performance on a modern CNC machine [8]. Kuram *et al.* researched on optimization of cutting fluid and cutting parameters during end milling by using D-optimal design of experiment. The paper focused on effect of the milled parts and the cutting function on the milling roughness. Most appropriate cutting fluid was selected in accordance with energy, tool life and surface roughness by using mathematical modeling [9]. Mohdzail *et al*. researched on minimizing surface roughness in end milling machining process by using application of GA to optimize cutting condition and this paper focused on comparing the result of the GA with RSM techniques to observe the optimum cutting condition for the minimum surface roughness [10]. Ghani *et al*. researched on end milling parameters. Their research paper focused on processing parameters like high cutting speed, low feed rate, and low depth of cut leading to better surface finish and low cutting force. They also used taguchi and ANOVA techniques for optimization [11]. Thakore researched on CNC end milling process parameters for aluminium 6061 alloy using carbide tool material by DOE. The paper concluded that by using DOE, surface roughness and MMR are mainly affected by the processing parameters like cutting speed, feed rate, and depth of cut [12].

METHODOLOGY

The optimization of machining parameters of end milling, various methods of optimization were carried out, namely, mathematical modeling, predictive and experimental method. The practical work for optimization was carried out using DOE.

There are various DOE techniques available for performing practical from these methods; different methods were used in accordance to level and machine boundary and validation with mathematical modeling and software was also carried out.

CONCLUSION AND FUTURE WORK

The review concludes that end milling process is generally done on VMC with given input parameters like cutting speed, feed rate, and depth of cut, which are the most affected parameters on irrespective output parameters like MRR, TWR, tool life, surface roughness and energy consumed.

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