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Study of Consistency in Multi-Response Optimization Generated with GRA using Sensitivity Analysis in Orthogonal Turn-mill and Lathe Processes Under Eco-friendly Conditions

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Abstract. This paper investigates the surface roughness and temperatures generated during metal machining processes such as lathe and orthogonal turn-mill operations on the most commonly used domestic material AISI 304 stainless steel. Grey relational analysis (GRA) is a tool for multi-response optimization that can be used in conjunction with the Taguchi approach is used for multi-response optimization. Furthermore, a sensitivity analysis utilizing regression models is performed to cross-check the consistency of GRA optimality with modifications in machining parameter levels. Use of sensitivity analysis resulted in much-finer machining parameter combinations for superior responses in environmentally friendly (dry and aerosol-mist conditions) machining in both the processes.

INTRODUCTION

The investigative strategy, model regression, and optimization are all common components of surface response technique. Model construction and optimization are approached in different ways. Dual Response Surface Optimization (DRSO) and Multi-Response Optimization (MRO) are two types of optimizations offered by Response Surface Methodology. If the second response value is appropriately limited, DRSO can assist practitioners in optimizing the main answer and optimize the mean response of quality uniqueness in MRO at the same time to reach the best location without taking standard response deviations into account. But Grey relational analysis (GRA) is a technique for reducing a multi-objective problem to a single aim [1-3]. GRA is a measurement technique that focuses on quantitative definition and comparison of variation. It calculates all forces and their interactions with various variables [4-6].

Under a known set of statements, a sensitivity analysis determines how different values of a self-determining variable influence a specified dependant variable. Sensitivity analysis also looks into how various sources of ambiguity in an arithmetical model contribute to total hesitancy. This technology is used and encircled by a defined border based on one or more variable attempts [7, 8].

MATERIALS AND METHOD

This work is carried on a turn-mill center (PMK; TMC-XL-200) which can conduct plain turning operation using single and multipoint cutting tools, on most commonly used domestic material like AISI 304 stainless steel. The Taguchi concept of designing the experiment are done with process variables cutting speed (rpm), tool feed (mm/rev for lathe operation; mm/min for orthogonal turn-mill operation) and depth of cut (mm) with four levels each. The designed experiments are determined to be L_{16} experiments. PVD-coated with Ti-Al-N over cutting tools (inserts in lathe operation; solid end mill cutter in orthogonal turn-mill operation) are used under dry and aerosol-mist environments. The responses like surface roughness and temperatures on workpiece and tool are determined using roughness tester and infrared non-contact guns, as shown in Table 1.

Cutting fluid which is water soluble with 1:20 ratio is used in form of aerosol-mist with a flow rate of 30 ml/min and 5.5 bar pressure to generate a cooling and lubricating effect. The measured responses are used to determine the

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