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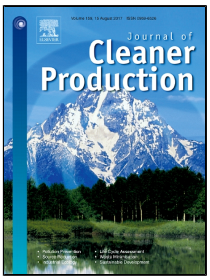


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# MULTI OBJECTIVE OPTIMIZATION USING DIFFERENT METHODS OF ASSIGNING WEIGHTS TO ENERGY CONSUMPTION RESPONSES, SURFACE ROUGHNESS AND MATERIAL REMOVAL RATE DURING ROUGH TURNING OPERATION

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Index Terms—Turning, multi objective optimization, energy consumption, power factor, energy efficiency, surface roughness, MRR, Taguchi-Method, AHP, TOPSIS, Entropy-Method

## ABSTRACT

The present research work focuses on simultaneous optimization of prime energy consumption responses, surface roughness and material removal rate for sustainable machining operations. The experiments were conducted on rough turning of EN 353 alloy steel with multi-layer coated tungsten carbide insert. The effect of input parameters: nose radius, cutting speed, feed rate and depth of cut along with their interactions were studied on the response parameters viz. power factor (PF), active power consumed by the machine (APCM), active energy consumed by the machine (AECM), energy efficiency (EE), surface roughness (Ra) and material removal rate (MRR). The Taguchi's $L_{27}$ orthogonal array had been used for design of experiments by using Minitab 16 software. The weights of importance to the responses were assigned by Equal, Analytical Hierarchy Process (AHP) and Entropy weights method. The multi performance composite index (MPCI) was obtained by Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method and was optimized with Taguchi method. The results showed that the MPCI with these three different weight criteria had different optimum control factor levels. At optimal turning parameters of MPCI using AHP weights, Equal weights and Entropy weights, there was an improvement in MPCI of 319.72%, 45.38% and 9.02% respectively compared to turning parameters in common use. The depth of cut was found to be a vital parameter for MPCI with AHP weights and nose radius for MPCI with Equal and Entropy weights. Hence the choice of method of assigning weights of importance to the responses and even the optimization method plays important role in decision making in multi objective optimization.

## ABBREVATIONS:

| | | | |
|---|---|---|---|
| A | : Cutting Speed | MPCI | : Multi Performance Composite Index |
| A*B | : Interaction of Cutting Speed and Feed Rate | MRR | : Material Removal Rate |
| A*C | : Interaction of Cutting Speed and Depth of Cut | n | : Number of Experiments |
| A*D | : Interaction of Cutting Speed and Nose Radius | nor | : Number of Responses in the Factor Level Combination |
| ACE | : Active Cutting Energy | OA | : Orthogonal Array |
| ACP | : Active Cutting Power | PC | : Percentage Contribution |
| AECM | : Active Energy Consumed by the Machine | PF | : Power Factor |
| AHP | : Analytical Hierarchy Process | $p_{ij}$ | : Probability of Matrix |
| ANOVA | : Analysis of Variance | $q_{ij}$ | : An Element of the Decision Matrix |