

Chapter 24

Sustainable Operation Planning and Optimization in Manufacturing: A Case with Electro–Discharge Machining

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ABSTRACT

Demands on today's products have become very complex as buyers expect enhanced quality. Choosing a proper integrated manufacturing technology is the most difficult and time consuming act for enterprises. Again, Planning plays a crucial role in embedding sustainability into the day to day operations and businesses maintain a strong focus on factors that have a clear and direct effect on their economic performance like cost of materials, profit etc. Electro-Discharge Machining (EDM) is a thermoelectric energy based non-traditional machining processes with Material Removal Rate (MRR), Overcut and Surface Roughness as important outputs. People working on EDM have used a number of ways to optimize them. The objectives being more efficient material removal coupled with reduction in overcut and improved surface quality. In this study the same are individually and simultaneously optimized using Taguchi method on EN41 material and the best combination of the input parameters were identified. Results are validated to show its efficacy in using these in different manufacturing shop floors

1. INTRODUCTION

Decision making is the acknowledged process used in upstream of industries; resulting in selection of a course of action among a set of alternative scenario. Manufacturing can be defined as application of physical, mechanical and chemical processes to modify geometry, properties and / or appearance of a

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given starting material in the line of making of new form, finished parts or products. Manufacturing industries are compelled to move away from traditional setups to more responsive and dynamic ones. Many new concepts have emerged from these changes, sustained by strategies aimed at meeting the challenges arising due to globalization. Product attributes like quality, reliability, cost, life-cycle prediction and organizational ability to meet market pressures like delivery and service, have come into picture. A long array of emerging technologies has opened up the potential for a variety of new products. Fast changing technologies on product front cautioned need for an equally fast response from manufacturing. Old traditional model of '*unfocused, short-term and non-holistic vision*' is becoming replaced by latest approach like '*focused, holistic and strategic vision*' under a sustainable world of manufacturing.

Demands for end products have become increasingly complex as customers expect enhanced performance across a variety of diverse and changing system operating conditions. Reconfigurable systems are having the capacity and functionality in order to meet new objectives and function effectively in changing operating conditions and capable to deliver value in dynamic market conditions. Reconfigurable system are designed to maintain a high level of performance by changing their configuration to meet the multiple function requirements or a change in operating conditions within acceptable reconfiguration time and cost. The configuration of a system can facilitate or impede the systems productivity, responsiveness, convertibility and scalability, and also impact its daily operations. Selection of system configuration along with machine type and its specifications is required for effective and efficient production and their arrangement in the most preferred configuration has dramatic effects on the performance of the manufacturing system.

Electrical Discharge Machining, also known as spark erosion, employs electrical energy to remove metal from the workpiece without touching it. A pulsating high-frequency electric current is applied between the tool point and workpiece, causing sparks to jump the gap and vaporize small areas of workpiece (FIGURE 1). As no cutting forces are involved, light, delicate operations can be performed on thin workpieces. EDM can produce shapes unobtainable by any conventional machining process.

Electrical discharge machining is considered as one of the most widely used non-traditional machining processes. Main attraction of EDM over traditional machining processes such as metal cutting using different tools and grinding is that this technique utilizes thermoelectric process to erode undesired materials from the work piece by a series of discrete electrical sparks between work piece and electrode. Working principle of this process is based on thermoelectric energy; is created between a workpiece and an electrode submerged in a dielectric fluid with passage of electric current. Workpiece and electrode are separated by a specific small gap called '*spark gap*'. Pulsed arc discharges occur in this gap filled with an insulating medium, preferably a dielectric liquid like hydrocarbon oil or de-mineralized water. This process has the ability to machine hard, difficult-to-machine materials. Parts with complex, precise and irregular shapes for forging, press tools, extrusion dies, difficult internal shapes for aerospace and medical applications can be made by EDM process.

2. LITERATURE REVIEW

Advanced manufacturing may be defined as the utilization of enabling technologies, incorporating design and business process innovation; to deliver high value added processes and products in ways that are novel, competitive and sustainable. *Need for it is: high production with low costs, automated data transmission, miniaturization, precise and ultra precession finishing etcetera.* Major drivers of advanced

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