

## Experimental Investigation and Analysis of Laser Cutting Process Parameters

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**Abstract**— Laser cutting is one of the popular unconventional processes in which complicated shapes of various types of materials were being cut. This paper investigates the effects of parameters associated with CO<sub>2</sub> laser cutting process of aluminium plate because aluminium is difficult to cut using laser due to back reflection and low penetrating power of laser. The experiment was carried out on the basis of L<sub>9</sub> Taguchi's orthogonal array. The laser cutting parameters viz. laser power, cutting speed, assist gas pressure, and stand-off distance were arranged at three levels. It has been found that the quality of the cut edges and kerf are affected by laser power, cutting speed, assist gas pressure, and the stand-off distance. From the investigation it is found that the parameters such as laser power, cutting speed, stand-off distance have major impact on surface roughness and kerf width. Whereas, the effect of assist gas pressure over surface roughness and kerf width is less significant.

**Keywords**— CO<sub>2</sub> Laser, Laser power, Cutting speed, Assist gas pressure, Stand-off distance, Surface finish, and Kerf width.

### I. INTRODUCTION

LASER stands for Light Amplification by Stimulated Emission of Radiation. Laser has a wide range of applications, ranging from military weapons to medical instruments. In industries laser is used as an unconventional method for cutting and welding. The main advantage of laser cutting is that, it is a non-contact operative method from which a good precise cutting of complicated shapes can be achieved. Also laser can be used to cut variety of materials like wood, ceramic, rubber, plastic and certain metals.

The most commonly used types of laser for laser cutting are CO<sub>2</sub> laser and Nd: YAG laser. CO<sub>2</sub> laser dominate this application due to their good quality beam combined to high output power and compared with other conventional mechanical processes, laser cutting removes little material, involves highly localized heat input to the workpiece thereby minimizing distortion and offers no tool wear. CO<sub>2</sub> laser has a wavelength of about 10.6 $\mu$ m due to this CO<sub>2</sub> laser has high power output when compared to Nd: YAG laser. Thus for cutting aluminum and aluminum based alloys CO<sub>2</sub> laser can be used.

In this paper, experimental work has been done to explore the influence of process parameters on the cut quality, such as: surface roughness and kerf width.

### II. WORKING PRINCIPLE

Miroslav Radovanovic and Milos Madic [1] stated that laser beam is a high intensity beam of light that can be tightly focused onto a spot of only 0.1 to 0.2 mm in diameter. The high power density of the focused laser beam in the spot melts or evaporates material in a fraction of a second and the molten material is removed with a coaxial current of the assist gas as shown in Figure 1.

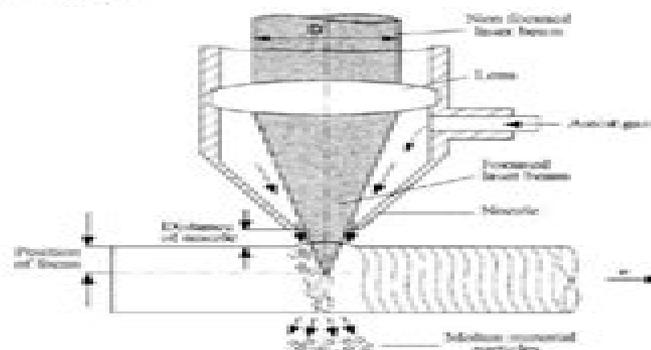


Figure 1. Laser beam cutting [1]

### III. LITERATURE REVIEW

#### A. Surface roughness.

Surface roughness is an effective parameter representing quality of a machined surface. Thawari, G. et al. [2] observed that surface roughness value reduces with increase in cutting speed and frequency and decrease in laser power and gas pressure. Milos Madic et. al. [3] observed that the cutting speed should be kept at the highest level (7m/min), assist gas pressure at the lowest level (3 bar), while laser power should be kept at an intermediate level (0.9 kW) for obtaining minimal surface roughness. Sundar et al. [4] concluded the following: decrease in assist gas pressure shows a good decrease in surface roughness; higher cutting speed produces low surface roughness; there is a direct relation between the laser power and the surface roughness and the

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**Experimental Investigations on Joining Techniques for Paper Structures** Evgenia Kanli,2021-08-26 The background of this research is related to innovative lightweight construction methods for short term applications realized with highly recyclable materials produced from renewable resources Specifically the possibility of using selected paper based products for design purposes is examined The main topic discussed regards the state of the art and future potential of joining techniques for assemblies and structures designed with paper based products In this context the preference on paper tubes for a variety of designs is examined closely A collection of case studies for selected joining techniques supported with digital tools fabrication of prototypes and targeted structural experiments demonstrates possibilities and considerations This book presents the research process and aims to inspire architects designers and engineers who are eager to discuss on material innovation and the steps that need to be taken to examine the feasibility of such ideas Advanced Engineering of Materials

Through Lasers J. Radhakrishnan,Sunil Pathak,2022-06-15 This book covers the fundamentals of different laser based manufacturing and processing namely laser shock peening laser micromachining laser cleaning cladding remelting laser honing and other several aspects of lasers The book discusses the general laser interaction with different materials The application of laser based post processing of additive manufacturing and repair engineering is reported It also provides the reader with mechanism of lasers in manufacturing and recent developments in tools technologies controls and operations

**Laser Cutting** Anders Ivarson,1991 Application of Lasers in Manufacturing Uday Shanker Dixit,Shrikrishna N. Joshi,J. Paulo Davim,2018-06-29 This book mainly addresses the applications of lasers in the manufacture of various industrial components The technologies presented here have scopes of application ranging from the macro to meso and micro level of components and features This book includes chapters on the basic and advanced applications of lasers in the manufacturing domain They present theoretical and practical aspects of laser technology for various applications such as laser based machining micro scribing texturing machining of micro sized channels laser welding laser based correction of sheet metal i e straightening laser forming and laser technology for 3 D printing Lasers have various applications such as the production of powerful lights for illumination or decoration measurement of velocity transportation and length interferometry printing recording communication bio medical instrumentation and pollution detection A significant body of literature is available on the physics of lasers and types of lasers However it has been noted there are a few books published on the applications of lasers in manufacturing domain a gap that this book remedies Gathering contributions by leading engineers and academicians in this area it offers a valuable source of information for young scientists and research students

*Advances in Industrial Automation and Smart Manufacturing* A. Arockiarajan,M. Duraiselvam,Ramesh Raju,2020-10-20 This book comprises selected peer reviewed proceedings of the International Conference on Advances in Industrial Automation and Smart Manufacturing ICAIASM 2019 The contents focus on innovative manufacturing processes standards

and technologies used to implement Industry 4.0 and industrial IoT based environment for smart manufacturing. The book particularly emphasizes on emerging industrial concepts like industrial IoT and cyber physical systems, advanced simulation and digital twin, wireless instrumentation, rapid prototyping and tooling, augmented reality, analytics and manufacturing operations management. Given the range of topics covered, this book will be useful for students, researchers as well as industry professionals.

**International Conference on Emerging Trends in Engineering (ICETE)** Suresh Chandra Satapathy, K. Srujan Raju, Kumar Molugaram, Arkanti Krishnaiah, George A. Tsihrintzis, 2019-07-26. This book constitutes the proceedings of the First International Conference on Emerging Trends in Engineering ICETE held at University College of Engineering and organised by the Alumni Association, University College of Engineering, Osmania University in Hyderabad, India on 22-23 March 2019. The proceedings of the ICETE are published in three volumes covering seven areas: Biomedical, Civil, Computer Science, Electrical, Electronics, Electronics Communication, Mechanical and Mining Engineering. The 215 peer-reviewed papers from around the globe present the latest state of the art research and are useful to postgraduate students, researchers, academics and industry engineers working in the respective fields. This volume presents state of the art technical contributions in the areas of civil, mechanical and mining engineering, discussing sustainable developments in fields such as water resource engineering, structural engineering, geotechnical and transportation engineering, mining engineering, production and industrial engineering, thermal engineering, design engineering and production engineering.

**Modern Machining Technology** Bijoy Bhattacharyya, Biswanath Doloi, 2019-09-17. Modern Machining Technology: Advanced Hybrid Micro Machining and Super Finishing Technology explores complex and precise components with challenging shapes that are increasing in demand in industry. As the first book to cover all major technologies in this field, readers will find the latest technical developments and research in one place, allowing for easy comparison of specifications. Technologies covered include mechanical, thermal, chemical, micro and hybrid machining processes as well as the latest advanced finishing technologies. Each topic is accompanied by a basic overview, examples of typical applications and studies of performance criteria. In addition, readers will find comparative advantages, model questions and solutions. Addresses a broad range of modern machining techniques providing specifications for easy comparison. Includes descriptions of the main applications for each method along with the materials or products needed. Provides the very latest research in processes including hybrid machining.

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**Proceedings of the International Conference on Integration and Commercialization of Micro and Nanosystems, 2007: Micro and nano systems ; Micro and nano devices ; Micro and nano mechanics ; Energy and micro and nano scale heat transfer** ,2007      **CIRP Journal of Manufacturing Systems** ,1999

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