JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

A REVIEW ON INVESTIGATING THE EFFECTS OF INPUT PARAMETERS FOR FIBER LASER MACHINING OF INCONEL 718.

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Abstract : The high-strength superalloy Inconel 718, which is frequently used in crucial aerospace and industrial applications, is machined with a fiber laser. This review paper investigates the influence of input parameters on this process. It investigates the effects of laser power, beam focus position, scanning speed, pulse duration, pulse frequency, and assist gas composition on machining outcomes through a review of the literature. Understanding parameter interactions and their effects on material removal rate, surface roughness, kerf width, and heat-affected zone are key takeaways from the review. To maximize process effectiveness and component quality, it is essential to address issues including heat damage and microstructural abnormalities. This paper offers useful insights for academics and engineers in expanding Inconel 718 applications in challenging industries by utilizing the benefits of fiber laser technology. Future research directions are suggested to investigate sophisticated laser machining methods and extend the capabilities of industrial and aerospace machining.

Keywords – Inconel 718, Effect of Input Parameters, LBM.

1 INTRODUCTION

Manufacturers are under pressure to cut back on the amount of lubricating oil they use for machining due to rising public awareness of the negative effects industry activities have on the environment and human health. Aerospace alloys like Inconel 718, which are challenging to manufacture materials, are utilized extensively in the aerospace sector. In essence, these materials are high temperature alloys, and their hardness is excessively high. Consumption of lubricant during the machining of aerospace alloys is particularly high, and there are significant costs connected with purchasing, disposing of, and cleaning the machined component. Aeronautical manufacturers aim to carry out dry machining or nearly dry machining in order to save manufacturing costs and make the process safe for the environment [1]. The efficiency of minimum quantity lubrication demonstrates that this method offers the least expensive option to flooded machines that are typically used. This method is conceptually dependent on a variety of factors, including cooling conditions, the type of lubricant used on the tool, the material of the work piece, etc. Cryogenic machining is now also utilized to cool the cut surfaces of tools and workpieces. Cryogenic machining offers increased machining performance in terms of decreased tool wear & temperature for high hardness alloys, such as Ni based alloys like Inconel 718. Additionally, it enhances the material's work piece's surface quality [2].

In many machining procedures, cutting fluids are crucial for reducing production time, cost, and energy. Nanofluid is a colloidal mixing of metallic and nonmetallic particles with an average size of 100 nanometers (nm) in conventional fluids. Because of their excellent tribological qualities, nanofluids are thought to be potential heat transfer fluids. When compared to dry and traditional flooded machining processes, the surface finish is better and there is more lubrication if the nanoparticle concentration in the base fluid is higher. This is because of the direct effect of the nanoparticles, which includes rolling, sliding, filming, and surface enhancement effect, which includes mending and polishing. In order to increase surface smoothness, nanofluid also lowers cutting forces, power consumption, tool wear, and friction coefficient [3].

In the aerospace sector, Inconel 718 is a high-temperature alloy that has been toughened. This type of material needs a greater surface polish as a minimum. Traditional machining It is challenging to get a superior surface finish while optimizing the Factorial Method 3 method for Fiber Laser Machining Inconel 718 parameters. As a result, dry and minimal lubricating techniques are employed. It still does not receive much surface finish, though. As studies on MQL with conventional fluid and MQL with nanofluid have been conducted. Additionally, certain nanoparticles have harmless properties, can be utilized as lubricants, and are environmentally beneficial.[4]. Turning, milling, drilling, and grinding are the four machining operations that have received the most

study attention. As machining techniques are typically designed to produce components with high-quality surfaces, surface finish is quite important. As a result, elements like vibrations and chip removal that are not as important on a larger scale have a big impact on surface finish. The surface integrity is one of the aspects that affects how well a product performs.

1.1 Laser Beam Machine

The machining method known as "Laser Beam Machining" (LBM) uses a laser beam to cut both metallic and non-metallic materials. In this technique, a high-intensity laser beam is directed at the workpiece, transferring thermal energy from the laser to the workpiece's surface. The components from the w/p are heated, melted, and vaporized by the heat thus produced at the surface. LASER stands for light amplification by stimulated emission of radiation. A high-powered laser beam is used by a laser beam machine's operating system to precisely carry out various material processing activities like cutting, engraving, and labelling. A laser source produces a coherent, strong beam of light to start the process. The power of the laser beam is then increased using optical components. The laser beam is then focused into a point with a high energy density by passing through focusing lenses. For precision material processing, the focused spot's size is essential. Depending on the application, the concentrated laser beam interacts with the target material to produce various effects. The material is rapidly heated and vaporized along the cutting path in laser cutting. While laser marking leaves permanent marks or modifications on the material's surface, laser engraving entails removing material from the surface layer. A computer numerical control (CNC) system regulates the motion of the machine and the position of the laser beam to produce accurate movements. Design data are converted into machine motions using specialized software, enabling precise execution of complex patterns. [5], [6].

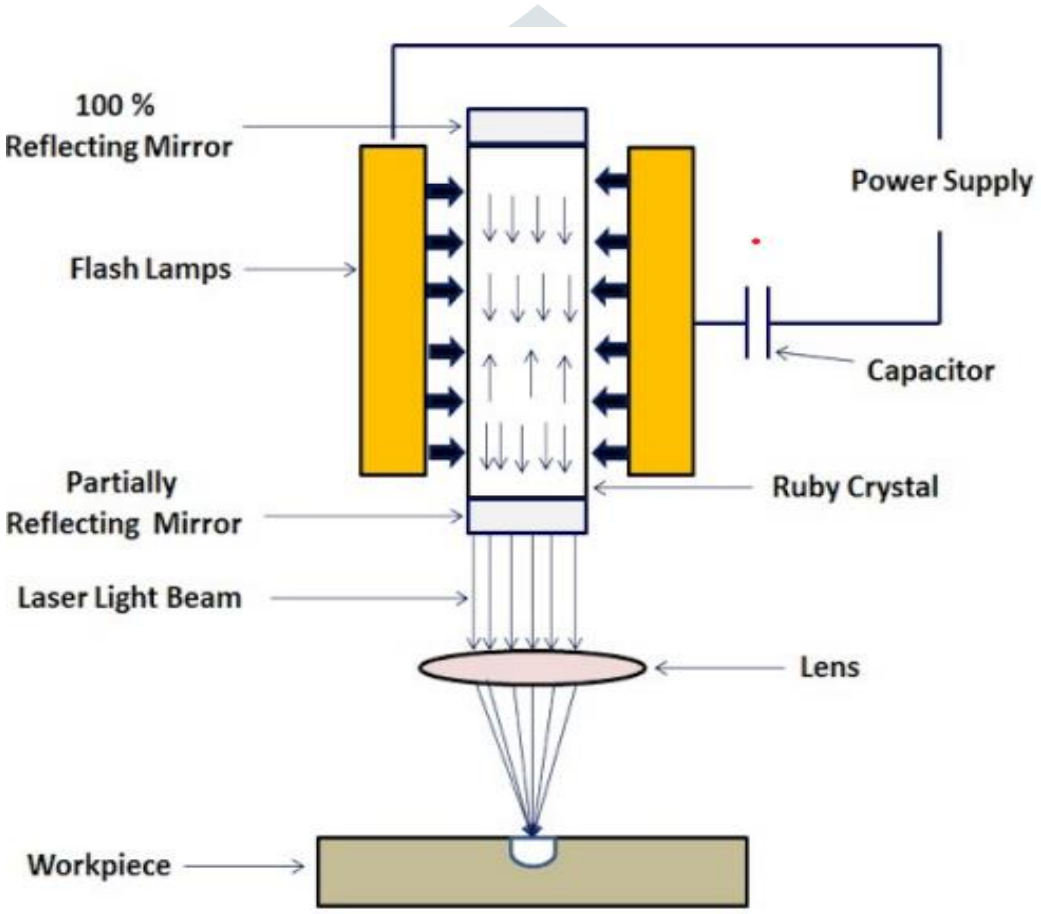

Fig. 1: Laser Beam Machine

An aid gas, like nitrogen or oxygen, may occasionally be employed to speed up the removal of materials. The gas improves cut quality and prevents overheating by blowing away debris and molten material. In general, laser beam machines provide flexibility, accuracy, and efficiency, revolutionizing material processing in a variety of industries including manufacturing, aerospace, automotive, electronics, and the medical sector.

2 LITERATURE SURVEY

Table 1: Literature survey

Sr. No.	Title of Research Paper	Author Name	Year	Remark
1	A Review of Developments towards dry and high-speed machining of Inconel 718.	D. Dudzinski, A. Devillez, A. Moufki, D. Larraouquere, V. Zerrouki, J. Vigneau.	2004	In order to improve machining effectiveness and surface quality for the superalloy Inconel 718, which is based on nickel, this study covers developments in dry and high-speed machining methods.
2	Environmental Impacts and Hazards Associated with Metal Working Fluids and Recent Advances in Sustainable Systems: A Review	M.S. Najiha, M.M. Rahman, A.R. Yusoff	2016	This review paper examines the environmental effects and dangers of metalworking fluids while showcasing recent developments in environmentally friendly technologies for safer metalworking procedures.
3	Evaluation of Machining Performance in Cryogenic Machining Inconel 718 and comparison with dry and MQL machining.	Yusuf Kaynak.	2014	The article assesses the effectiveness of cryogenic machining on Inconel 718 by contrasting it with dry and MQL machining techniques and emphasises its potential advantages for enhancing machining results.
4	Mechanism of Nanoparticles Functioning and Effects in Machining Processes: A Review	Anuj Kumar Sharma, Arun Kumar Tiwari, Amit Rai Dixit	2015	In order to shed light on their prospective uses and enable their optimisation for improved machining performance, the paper covers the mechanism and impacts of nanoparticles in machining operations.
5	The Use of Hybrid CO2+MQL in Machining Operations	O. Pereira, P. Catala, A. Rodriguez, T. Ostra, J. Vivancos, A. Rivero, L. N. Lopez de Lacalle	2015	The use of a hybrid CO2+MQL (Minimum Quantity Lubrication) system for machining processes is explored in this research, along with its potential advantages for cutting performance and environmental effect.
6	Effect of Minimum Quantity Lubrication with Gamma-Al2O3 Nanoparticles on Surface Roughness in Milling AISI D3 Material.	M. Hadi and R. Atefi.	2015	examined the effect of applying a small amount of Gamma-Al2O3 nanoparticle lubrication on surface roughness when milling AISI D3 material.
7	Application of Nanofluid in Machining Process - A Review	Y. Shokoohi, E. Shekarian	2016	The research provides a thorough analysis of the use of nanofluid in machining operations, highlighting both its advantages and disadvantages.
8	: State of the art in Surface Integrity in Machining of Ni-Based Alloys	A. Thakur, S. Gangopadhyay	2018	Analysis of the state of surface integrity in the machining of Ni-based alloys, providing insights into the difficulties and developments in the field.
9	Measurement and analysis of surface roughness in WS2 solid lubricant assisted minimum quantity lubrication (MQL) turning of Inconel 718	Uma Maheshwera Reddy Paturi, Yesu Ratnam Maddu, Ramalinga Reddy Maruri, Suresh Kumar Reddy Narala	2016	In order to provide insights for improved machining procedures, the research examines the effects of WS2 solid lubricant assisted MQL turning on surface roughness in Inconel 718.

10	Experimental evaluation of the lubrication performance of MoS2/CNT nanofluid for minimal quantity lubrication in Ni-based alloy grinding	Yanbin Zhang, Changhe Li, Dongzhou Jia, Dongkun Zhang, Xiaowei Zhang	2015	The usefulness of MoS2/CNT nanofluid as a lubricant in small amounts during the grinding of Ni-based alloys was examined.
11	Environmentally friendly cutting fluids and cooling techniques in machining: A Review	Sujan Debnath, Moola Mohan Reddy, Qua Sok Yi	2014	examined sustainable and ecologically friendly machining processes, with a focus on cutting fluids and cooling methods.
12	Robust design of using nanofluid/MQL in micro-drilling	Wei-Tai Huang, Der-Ho Wu, Jian-Ting Chen	2015	studied the use of nanofluid in minimum quantity lubrication during micro-drilling procedures using a robust design approach.
13	Nano-Cutting Fluid for Enhancement of Metal Cutting Performance	S. Khandekar, M. Ravi Sankar, V. Agnihotri, and J. Ramkumar	2012	investigated the use of nano-cutting fluid to increase metal cutting process performance to improve machining effectiveness and surface quality.
14	Experimental Study on Micro end Milling Process of Ti-6Al-4V Using Minimum Quantity Lubrication (MQL)	Dae Hoon Kim, Pil-Ho Lee, Jung Sub Kim	2014	Ti-6Al-4V micro end milling with MQL was investigated, with cutting forces, surface roughness, and tool wear being examined.
15	Prediction of Surface Roughness in High-Speed Milling of Inconel 718 Under MQL Using RSM Method	M.S. Kasim, C.H.Che Haron, J.A. Ghani, M.A Sulaiman	2013	Enhanced machining process optimisation by using the RSM approach to forecast surface roughness during high-speed milling of Inconel 718 with MQL.
16.	Experimental study in Micro milling of milling of Inconel 718 by Fiber Laser Machining	S.C. Borse and M.S. Kadam	2018	Study the effect of laser process parameters on the quality of the features obtained by laser machining.
17.	Laser Beam Micromachining on Inconel- A Review	Lakhan Agarwal, Sachin Borse	2017	Discuss the rise of cutting-edge building materials and utilization of traditional machining techniques.

3 CONCLUSION

The importance of comprehending the effects of input parameters in the fiber laser machining of Inconel 718 is highlighted by this literature review's conclusion. Researchers, engineers, and practitioners can use it to improve the machining procedure and expand the capabilities of fiber laser technology for cutting difficult materials like Inconel 718, which eventually helps progress many industrial sectors. To fully realize the potential of this cutting-edge technology for aerospace and other high-performance applications, additional research directions are suggested to delve deeper into parameter interactions and investigate improved laser machining processes.

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