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Review

Laser Cutting: A Review on the Influence of Assist Gas

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Abstract: Assist gas plays a central role in laser fusion cutting. In this work, the aerodynamic interactions between the assist gas and the workpiece are reviewed. An insight into those phenomena that hinder the cutting quality and performance is provided. These phenomena include shock waves, choking, boundary layer separation, etc. The most relevant and promising attempts to overcome these common problems related to the gas dynamics are surveyed. The review of the current scientific literature has revealed some gaps in the current knowledge of the role of the assist gas dynamics in laser cutting. The assist gas interactions have been investigated only under static conditions; and the dynamic interaction with the molten material on the cutting front has not been addressed. New nozzle designs with improved efficiency of molten material removal are required to improve cut quality; and cutting speed in current industrial laser cutting machines; especially in those assisted by new high-brightness laser sources

Keywords: laser cutting; assist gas; nozzles; shock waves

1. Introduction

Laser cutting was one of the first industrial applications of lasers, and one of the most widespread in the manufacturing industry since the birth of laser technology. The first reported attempt to use a laser as a cutting tool may be well attributed to P. Houldcroft, who in 1967 used a 300 W CO_2 laser with oxygen as assist gas to cut 1 mm thick steel sheet [1]. Currently, this kind of processing is routinely applied to cut steels, ranging from 0.5–30 mm in thickness for different purposes, as well as other engineering materials. The high material versatility, edge quality, easy automation and operation, accuracy and production flexibility in combination with a high material utilization and virtually no tool wear, are just some of the advantages over other conventional and non-conventional cutting methods. Laser cutting machines are mainly used to shape, cut, bore, drill, or tap metal components. Many different industries currently apply laser cutting, including the automobile, aerospace, medical devices, renewable energy, semiconductors, and consumer electronics industries.

Consuming approximately 25% of the total energy in Europe [2], the manufacturing industry is responsible for a substantial part of the total environmental impact. Furthermore, this impact is expected to increase, taking into consideration the current trend towards more energy intensive processes [3]. One would think that laser cutting had reached its maximum efficiency; however, the process has not been pushed to its limits, and it still has the potential to be tuned to a greater extent than at present.