سامية محمد مصطفى

شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

سامية محمد مصطفى

شبكة المعلومات الجامعية

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التوثيق الالكتروني والميكروفيلم

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سامية محمد مصطفى

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

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بالرسالة صفحات لم ترد بالأصل

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
DESIGN AND PRODUCTION ENGINEERING DEPARTMENT

OPTIMIZATION OF CO_2 LASER CUTTING PARAMETERS FOR ADVANCED MATERIALS

A Thesis Submitted in Partial Fulfillment for the Requirements of the Degree of Ph.D. in Mechanical Engineering

(Design and Production Engineering)

by

Eng. Ahmed Mohamed El Wardany Mohamed

M.Sc. In Mechanical Engineering
(Design and Production Engineering)
Faculty of Engineering, Ain Shams University, 2014

Supervised by

Prof. Dr. Mohamed Abdel Mohsen Sayed Mahdy

Prof. Dr. Hesham Aly Abdel Hamid Sonbol

Cairo – (2019)

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Supervising Committee

Name, Title and Affiliation — Signature

Prof. Dr. Mohamed Abdel Mohsen Sayed Mahdy ……

Professor of Production Engineering,
Design and Production Engineering Department,
Faculty of Engineering, Ain Shams University.

Prof. Dr. Hesham Aly Abdel Hamid Sonbol ……

Professor of Production Engineering,
Design and Production Engineering Department,
Faculty of Engineering, Ain Shams University.

Date : 11 April 2019

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EXAMINERS COMMITTEE

Name, Title and Affiliation — Signature

Prof. Dr. Samy Jimmy Ebeid ……..……

Professor of Production Engineering,
Design and Production Engineering Department,
Faculty of Engineering, Ain Shams University.

Prof. Dr. Ahmed Mohamed Abdel Aziz Kohail ……..……

Professor of Production Engineering,
Manufacturing Engineering and Production Tech. Department,
Modern Academy for Engineering and Technology.

Prof. Dr. Mohamed Abdel Mohsen Sayed Mahdy ……..……

Professor of Production Engineering,
Design and Production Engineering Department,
Faculty of Engineering, Ain Shams University.

Prof. Dr. Hesham Aly Abdel Hamid Sonbol ……..……

Professor of Production Engineering,
Design and Production Engineering Department,
Faculty of Engineering, Ain Shams University.

Date : 11 April 2019

Researcher data

Name: Ahmed Modamed El Wardany Mohamed

Date of birth: February 11, 1984

Place of birth: Giza, Egypt

Last academic degree: Master of science in mechanical engineering

Field of specialization: Design and production Engineering

University issued the degree: Ain shams university

Date of issued degree: June 2014

Current job: Lecturer assistant, Modern academy for engineering and technology

Email : wardany2012@gmail.com

Statement

This thesis is submitted as partial fulfillment of Doctor of Philosophy in Mechanical Engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no Part of it has been submitted for a degree or qualification at any other scientific entity.

Ahmed Mohamed El Wardany Mohamed

Signature

…….

Date : 11 April 2019

Abstract

Laser beam cutting is one of the major applications of lasers in sheet metal working. In this thesis, an experimental study in CO_2 laser cutting process is presented. The aim of this research is to investigate the effect of the laser cutting process variables on the cutting-edge quality parameters. Further to develop mathematical models and optimize the various laser cutting variables for each of the studied materials. Two different techniques namely: statistical regression and artificial neural networks were used to develop the mathematical models. Three difficult to cut materials namely: stainless steel 316, Armox500T, and aluminum AG5 were chosen as workpiece materials in this research. A 4.4 kW CO_2 Bystar L 4025-65 industrial laser cutting machine was used to perform the cutting operations. Several experiments were conducted to investigate the influence of four input variables: focal plane position, assist gas pressure, laser power, and cutting speed on the four most important performance parameters, namely: upper kerf width, lower kerf width, kerf taper angle, and the arithmetic average surface roughness R_a. The experimental plan was performed using L_{32} $1^2 \times 3^4$ Taguchi standard orthogonal matrix. The developed ANN models are based on multilayer feed-forward neural networks. The experimentally acquired data was used to train, validate and test the ANN performance, and special graphs were drawn for this purpose. Minitab software was used to build up the mathematical models using regression analysis. As well as to generate the main effects plot for the process variables on the performance parameters in order to determine the most significant variables. The developed models were validated and proved their capability to predict the laser cutting process output parameters for certain input variables inside the covered range of this study. Genetic optimization search algorithm was used to suggest the near optimal setting combinations of the four input variables in their operating range, to achieve a minimum of surface roughness R_a and kerf taper angle θ_k.

This research would provide a good demonstration for the most significant input variables and new models based on regression, and ANN technique to predict the cutting-edge quality parameters, which can be used for solving related industrial problems.

Keywords

Laser beam cutting, stainless steel 316, ARMOX 500T, aluminum AG5, artificial neural networks, genetic algorithm, surface roughness, upper kerf width, lower kerf width, kerf taper angle.

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Table of Contents