سامية محمد مصطفى

شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

سامية محمد مصطفى

شبكة المعلومات الجامعية

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

سامية محمد مصطفى

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

سامية محمد مصطفى

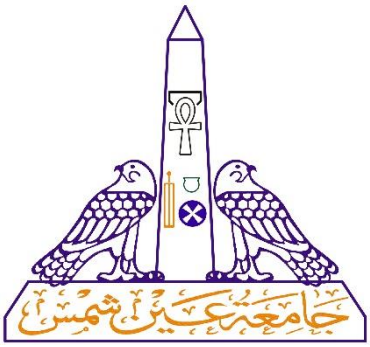
شبكة المعلومات الجامعية

بعض الوثائق الأصلية تالفة

سامية محمد مصطفى

شبكة المعلومات الجامعية

بالرسالة صفحات لم ترد بالأصل



AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Design and Production Engineering Department

Optimization of Abrasive Water Jet Cutting Parameters for Advanced Materials

A Thesis submitted in partial fulfillment of the requirements of the degree of

Doctor of Philosophy in Mechanical Engineering

(Design and Production Engineering)

by

Yahia Mahmoud Abdel Wahab Hassan Elattar

Master of Science in Mechanical Engineering

(Mechanical Design and Production Engineering)

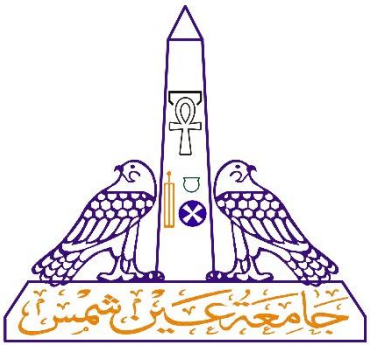
Faculty of Engineering, Cairo University, 2015

Supervised By

Prof. Mohamed Abdel Mohsen Sayed Mahdy

Prof. Hesham Aly Abd El-Hameed Sonbol

Cairo - (2019)



AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Design and Production Engineering Department

Optimization of Abrasive Water Jet Cutting Parameters for Advanced Materials

by

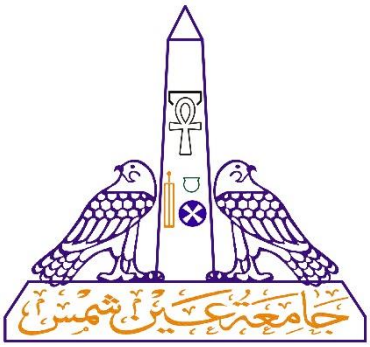
Yahia Mahmoud Abdel Wahab Hassan Elattar

Master of Science in Mechanical Engineering
(Mechanical Design and Production Engineering)
Faculty of Engineering, Cairo University, 2015

Supervising Committee

Name and Affiliation	**Signature**
Prof. Mohamed Abdel Mohsen Sayed Mahdy Professor of Mechanical Engineering, Design and Production Engineering Department, Faculty of Engineering, Ain Shams University	……
Prof. Hesham Aly Abd El-Hameed Sonbol Professor of Mechanical Engineering, Design and Production Engineering Department, Faculty of Engineering, Ain Shams University	……

Date : 18 / 4 / 2019



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Design and Production Engineering Department

Optimization of Abrasive Water Jet Cutting Parameters for Advanced Materials

by
Yahia Mahmoud Abdel Wahab Hassan Elattar
Master of Science in Mechanical Engineering
(Mechanical Design and Production Engineering)
Faculty of Engineering, Cairo University, 2015

EXAMINERS' COMMITTEE

Name and Affiliation	**Signature**
Prof. Samy Jimmy Ebeid Professor of Mechanical Engineering, Design and Production Engineering Department, Faculty of Engineering, Ain Shams University	.....
Prof. Abdelnasser A. M. Zayed Professor of Mechanical Engineering, Design and Production Engineering Department, Military Technical College	.....
Prof. Mohamed Abdel Mohsen Sayed Mahdy Professor of Mechanical Engineering, Design and Production Engineering Department, Faculty of Engineering, Ain Shams University	.....
Prof. Hesham Aly Abd El-Hameed Sonbol Professor of Mechanical Engineering, Design and Production Engineering Department, Faculty of Engineering, Ain Shams University	.....

Date : 18 / 4 / 2019

Statement

This thesis is submitted as a partial fulfilment 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 a qualification at any other scientific entity.

Yahia Mahmoud Abdel Wahab Hassan Elattar

Signature

……

Date: 18 / 4 / 2019

Researcher Data

Name:	Yahia Mahmoud AbdelWahab Hassan Elattar
Date of birth:	25 January 1985
Place of birth:	Sharkia
Last academic degree:	M.Sc. Mechanical Engineering
Field of specialization:	Mechanical Design and Production Engineering
University issued the degree:	Cairo University
Date of issued degree:	August 2015
Current job:	Lecturer assistant, Modern Academy for Engineering & Technology
Email:	ymelattar@cu.edu.eg

Abstract

Advanced materials such as alloys, and composite materials etc. are replacing other materials in many different manufacturing applications. This is due to the improvements achieved in their engineering properties. Among various advanced materials come the *Armox 500T*, *Titanium alloy Ti-6Al-4V*, and *CFRP laminates*. These materials are exploited in many military and industrial applications especially in the Egyptian industry. The demand on these advanced materials acquire non-traditional machining techniques for better cutting performance. Because of they are often offering high strength and hardness. Productivity in terms of material removal rate beside the cutting surface quality particularly surface roughness and kerf tapering are the most commonly issues encountered with production engineers during machining these materials.

Abrasive waterjet (AWJ) is one of the advanced machining processes applied widely in industry. It is superior to many other cutting techniques in processing various materials, particularly in processing difficult-to-cut materials. AWJ has many advantages like no heat affected zone. And has the ability to cut very complicated shapes and profiles. Besides the produced cutting surface has a good acceptable surface roughness value. In other words, there is no need for a secondary machining process. This technology is being progressively used in various industries. However, its cutting capability in terms of the material removal rate and kerf tapering are the major obstructions limiting its further applications.

Artificial intelligence (AI) has been established as the area of computer science dedicated to produce software capable of sophisticated, intelligent, computations similar to those that the human brain routinely performs. AI techniques have gained popularity in engineering applications in recent years due to their efficiency and effectiveness. Artificial neural network (ANN) and genetic

algorithm (GA) are two of the most promising AI techniques. ANN and GA techniques has been conducted to estimate optimal process parameters in AWJ operation. These two techniques are both considered to be appropriate in the process of modeling and optimization for AWJ machining process.

Scope and aim of this study are to investigate, model, and optimize the AWJ process in order to improve the AWJ process performance. Firstly, an experimental investigation is undertaken to study the major cutting performance measures in AWJ of three selected advanced materials. The considered AWJ process parameters include traverse speed, waterjet pressure, abrasive flow rate, and stand-off distance. The significant control factors have been found with further discussion of their effect on material removal rate, surface roughness, and kerf taper. Secondly, ANN models were introduced as one of the AI techniques. ANN with a back-propagation algorithm and a feed forward structure has been developed for these proposed models. Proposed ANN models were trained using conducted experimental data. ANN Models are verified and validated before implementation in optimization process. Finally, multi-objective optimization was carried out using genetic algorithm technique. GA technique was applied to obtain maximum material removal rate (MRR) with minimum surface roughness (Ra), and minimum kerf tapering (KT).

It was evidence that multi-objective optimization using GA is capable of offering sets of optimal solutions. These sets of optimal solutions include a combination of AWJ process parameters settings to obtain satisfying MRR, Ra, and KT according to production engineer requirements.

Keywords: abrasive - water jet - non-traditional machining - AWJ - AWJM - artificial intelligent - neural networks - ANN - genetic algorithm - GA - Armox - titanium alloy - Ti-6Al-4V - CFRP - surface roughness - material removal rate - kerf tapering - Ra - MRR - KT

Acknowledgment

The most important acknowledge is to Allah Almighty for blessing and giving me strength to accomplish this thesis.

It is an honor on itself to have such this great opportunity working under supervision of ***Prof. Mohamed Abdel Mohsen Sayed Mahdy*** and ***Prof. Hesham Aly Abd El-Hameed Sonbol*** as I pursued my degrees at Ain Shams University. This work would not have been possible without their backing, help and support.

In addition, I would like to express my deep thanks and gratitude to ***Prof. Ahmed Abdel-Aziz Kohail*** for his valuable contributions during the progress of this work, and for his continuous guidance and encouragement. I am also grateful to my colleague ***Dr. Ahmed El-Wardany*** for his advice and continuous support.

Also, a special thank goes to ***Eng. Mohamed El-Daw*** for his cooperation and assisting in conducting the experimental work at his own factory.

Last, but not least, I would express my appreciation to my family, and in particular ***Dina, Mona, Lara,*** and ***Mazen*** for their support and patience during my work.

Table of Contents