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

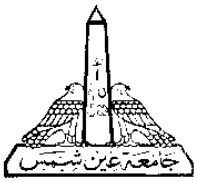
شبكة المعلومات الجامعية

بعض الوثائق الأصلية تالفة

سامية محمد مصطفى

شبكة المعلومات الجامعية

بالرسالة صفحات لم ترد بالأصل



AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Mechanical Power Engineering

Effects of Blade Design Parameters on The Performance of a HAWT

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

Master of Science in Mechanical Engineering

(Mechanical Power Engineering)

by

Zakaria Mostafa Abdo Salim Marouf

Bachelor of Science in Mechanical Engineering

(Mechatronics Engineering)

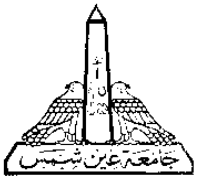
Supervised By

Prof. Dr. Mahmoud Abdel Rasheed Nosier

Prof. Dr. Mohamed Rafat Okelah

Prof. Dr. Ashraf Ghorab

Cairo - (2019)



AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Mechanical Power

Effects of Blade Design Parameters on The Performance of a HAWT

by

Zakaria Mostafa Abdo Salim Marouf

Bachelor of Science in Mechanical Engineering

(Mechatronics Engineering)

Examiners' Committee

Name and Affiliation	**Signature**
Prof. Dr. Ismail A. Tag	…….
Mechanical Power , Arab academy for Science Technology & Maritime Transport	
Prof. Dr. Kaddah Shaker Kaddah	…….
Mechanical Power , Ain Shams University	
Prof. Dr. Mahmoud Abdel Rasheed	…….
Mechanical Power , Ain Shams University	
Prof. Dr. Mohamed Rafat Okelah	…….
Mechanical Engineering, Future University in Egypt	

Statement

This thesis is submitted as a partial fulfilment of Master of Science 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.

Zakaria Mostafa Abdo Salim Marouf

Signature

……..…….

Date:23 April 2019

Researcher Data

Name	: Zakaria Mostafa Abdo Salim Marouf
Date of birth	: 09/04/1991
Place of birth	: El-Dakahlia, Egypt
Last academic degree	: Bachelor of Science in Engineering
Field of specialization	: Mechanical Engineering Department
University issued the degree	: Future University in Egypt (FUE)
Date of issued degree	: July 2014
Current job	: Teaching Assistant, Mechanical Engineering Department, Faculty of Engineering and Technology, Future University in Egypt

Thesis Summary

In view of the increasing concerns about wind energy exploitation as one of the promising alternatives of renewable energy systems, numerous efforts are directed to rotor blades design in order to achieve the best performance. Forces acting on rotor blades of horizontal axis wind turbine (HAWT), and hence the turbine power coefficient, are greatly affected by deviations in blade profile shape and surface roughness from design conditions. Both may change due to environmental impacts such as dust, sand, ice…etc. One of the methods proposed for restoring performance of blades suffering from such changes is to attach a winglet at the tip of the blades.

The present work examined the winglet effect on blade performance at different operating conditions. An experimental study on a model of HAWT was carried out at the project laboratory to investigate the winglet positive effect on power coefficient. Blades are tested in six modes namely; clean surface with and without winglet, rough surface with 1-mm and 3-mm height models and rough surface with 1-mm and 3-mm height models provided with winglet.

Primary variables were measured at different air speeds and blade angles of attack, and performance parameters were deduced. A remarkable improvement in power coefficient was generally obtained.

A winglet effect, WE, was investigated to show the effect of winglet on blade performance. It was shown that mounting winglets at the tips of the blades have positive and negative variations in power coefficient depending on operating conditions.

A restoration factor, RF, was introduced to indicate how much of the blade-power lost due to increased surface roughness could be restored when attaching a suitable winglet. Although RF varies greatly with operating conditions, with values ranging between zero% to 100%, its average positive effect was obvious. The favorable effect of the winglet extended to include improving the performance of blades even at the clean mode (designed). A power enhancement factor, PEF, was thus introduced and estimated. Calculated results showed an increase in power coefficient exceeding 20% at test conditions.

Key words:

HAWT, Blade Surface Roughness, Winglet, Power Coefficient, Restoration Factor.

Acknowledgment

And my success is not but through Allah. Upon him I have relied, and to Him I return. Thanks go first and final to **Allah** who gave me the patience to complete this work.

I would like to express my sincere appreciation and gratitude to my supervisors, **Prof. Dr. Mohamed Rafat Okelah**, **Prof. Dr. Mahmoud Abdel Rasheed** and **Prof. Dr. Ashraf Ghorab** who have been very helpful in providing guidance and support in my work.

Special thanks to **Faculty of Engineering and Technology, Future University in Egypt** for allowing me to use wind tunnel laboratory and other lab facilities for the experimental part of my research.

I'm also indebted to all my family members for their continuous encouragement and support throughout the work.

April 2019

Table of Contents

List of Figures