NUMERICAL AND EXPERIMENTAL INVESTIGATIONS OF A DIFFUSER AUGMENTED WIND TURBINE PERFORMANCE

By

Eng.: Mohamed Badr Saad Farghaly

A Thesis Submitted To The
Faculty of Engineering at Cairo University
In Partial Fulfillment Of The
Requirement for the Degree Of
DOCTOR OF PHILOSOPHY

In
AEROSPACE ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2017

NUMERICAL AND EXPERIMENTAL INVESTIGATIONS OF A DIFFUSER AUGMENTED WIND TURBINE PERFORMANCE

By

Eng.: Mohamed Badr Saad Farghaly

A Thesis Submitted To The
Faculty of Engineering at Cairo University
In Partial Fulfillment Of The
Requirement for the Degree Of
DOCTOR OF PHILOSOPHY
In
AEROSPACE ENGINEERING

Under the Supervision of

Dr. Galal Bahgat Salem,
Professor, Aerospace Department
Faculty of Engineering
Cairo University, Egypt

Dr. Farouk Mohamed Owis,
Professor, Aerospace Department
Faculty of Engineering
Cairo University, Egypt

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2017

NUMERICAL AND EXPERIMENTAL INVESTIGATIONS OF A DIFFUSER AUGMENTED WIND TURBINE PERFORMANCE

By

Eng.: Mohamed Badr Saad Farghaly

A Thesis Submitted To the Faculty of Engineering at Cairo University in Partial Fulfillment of the Requirement for the Degree Of

DOCTOR OF PHILOSOPHY

In

AEROSPACE ENGINEERING

Approved By the Examining Committee

Prof. Dr. Galal Bahgat Salem, Thesis Main Advisor
Professor Emeritus, Aerospace Department, Faculty of Engineering, Cairo University, Egypt

---

Prof. Dr. Farouk Mohamed Owis, Thesis Main Advisor
Professor, Aerospace Department, Faculty of Engineering, Cairo University, Egypt

---

Prof. Dr. Mohamed Madbouli Abdelrahman, Internal Examiner
Professor Emeritus, Aerospace Department, Faculty of Engineering, Cairo University, Egypt

---

Prof. Dr. Yehia Bahei-El-Din, External Examiner
Vice President for Research and Postgraduate Studies, British University in Egypt

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2017

Engineer's Name: Mohamed Badr Saad Farghaly
Date of Birth: 29 / 7 / 1984
Nationality: Egyptian
E-mail: Bader_pilot@yahoo.com
Phone: 01008200258
Address: 21 Abd El-Ghany Elbeshry St, Dr-Hamoda St, El- Nakel, El Haram – Giza - Egypt

Registration Date: 1 / 10 / 2012
Awarding Date: / / 2017
Degree: Doctor of Philosophy

Department: Aerospace Engineering

Supervisors:

Prof. Galal Bahgat Sale (Cairo University)
Prof. Farouk Mohamed Owis (Cairo University)

Examiners:

Porf. Galal Bahgat Salem (Main Advisor)
Prof. Farouk Mohamed Owis (Advisor)
Prof. Mohamed Madbouli Abdelrahman (Internal Examiner)
Prof. Yehia Bahei-El-Din (External Examiner)

Title of Thesis:

NUMERICAL AND EXPERIMENTAL INVESTIGATIONS OF A DIFFUSER AUGMENTED WIND TURBINE PERFORMANCE

Key Words:

Flanged diffuser, Diffuser augmented wind turbine, Wind turbine blades, Wind tunnel experiment, and tunnel test of a diffuser augmented wind turbine.

Summary:

The main purpose of the present thesis is investigate numerically and experimentally how to improve the performance characteristics of a DAWT system that may be used as an independent power supply to the remote and rural areas in Arab Republic of Egypt. The various diffuser geometric shape parameters that significantly affect the diffuser efficiency are studied numerically aiming to reaching the best diffuser configurations which satisfy the maximum approaching wind speed near the diffuser entrance. The subsequent improvement of the turbine performance characteristics due to applying the best diffuser configurations are calculated and compared with the conventional wind turbine. In additional, experimental tests are performed to validate the numerical models adopted in the current study.

Acknowledgment

All gratitude is due to ALLAH the all mighty God.

I would like to express my sincere appreciation to my supervisors Prof. Dr. Galal Bahgat Salem, and Prof. Dr. Farouk Mohamed Owis of the department of Aerospace engineering, Cairo University, for their deep interest in the subject of this research, their guidance, invaluable discussions in numerous aspects, and for their encouragement throughout this work.

I am also indebted to my father, mother, wife, brothers and sisters for their patience and unceasing encouragement, and their support throughout the work and also for giving me the motive to finish this thesis.

Special thanks to Engineers Ahmed Helmy, Mohamed Ali Mahmoud and Moamen Badr of the department of Aeronautical engineering, Institute of Aviation Engineering and Technology, for their efforts to manufacture and test the experimental model and for his support throughout this work.

I owe so much to Eng. Mohamed Mustafa, Manager of Techno Tools Factory, Industrial Zone, for supporting me by the materials required for the manufacturing process, technical data. Also full thanks to engineers and technicians of the Techno Tools Factory, especially to Mr. Kalid M. Elsayed for his great technical support and help me by the required technical consultancy during the manufacture processes.

Special thanks to my dear friend Dr. Eslam S. Abd Elghany, Engineer Ahmed H. Badry, Institute of Aviation Engineering and Technology, for their efforts and for giving me the motive to finish this thesis. Finally; full thanks to all staff, engineers and technicians of the Institute of Aviation Engineering and Technology.

Affectionately Dedicated

To

MY BELOVED MOTHER, FATHER, WIFE,
DAUGHTER AND MY BROTHERS

For their Patience and Encouragement
That made this work possible

Table of Contents