منسّق:الخط: ٢٠ نقطة، غامق، لون الخط: أسود، خط اللغة العربية وغيرها: semiT Roman weN، ٢٠ نقطة، غامق

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of a Wind Turbine in a Dusty Environmen

منسّق:الخط: Calibri، ٢٠ نقطة، غامق، خط اللغة العربية وغيرها: ٢٠ نقطة، غامق

A thesis submitted in partial fulfillment of the requirements for the degr
of Science at the Faculty of Engineering, Ain Shams Universit

By

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Graduate Program in Mechanical Engineering

Ain Shams University

2015

Under the Supervision of~~Supervisors~~

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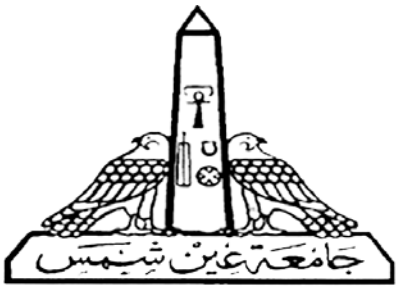

Faculty of Engineering
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Investigation of the Flow Characteristics of a Wind Turbine in a Dusty E

By

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B.Sc., Mechanical Engineering, Mechanical power section
Ain Shams University, 2009

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Date: 15st of December, 2015.

STATEMENT

This thesis is submitted in partial fulfilment of the Master of Science in Mechanical E
Faculty of Engineering, Ain shams University.

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

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Date: 26 I

ABSTRACT

When a wind turbine operates in a Saharan environment under dusty flow condi time, the surface roughness of the blade will increase due to dust accumula roughness may lead to severe drop in performance parameters (C_L, C_D), which in tu significant drop in turbine power. This work is done to provide the details of dus process over the wind turbine blades and to record the subsequent effects o parameters. A numerical model is created in addition to a deposition model for part using computational fluid dynamics (CFD) package FLUENT to record the performance for wind turbines which operates in dusty environments. The deposi created to simulate the dust build up over the blade surface. This deposition model in *C*-language using FLUENT's user defined functions (*UDF*) capability as a wall bou for the blade surface upon particle impact. First the deposited mass in each cell surface after a certain operational time was obtained and stored using the deposit with the FLUENT's user defined memory location (*UDML*) functions. This mass was into an equivalent roughness height to estimate the new surface profile of the blad deterioration in performance parameters is explored for the new profiles after eac over one year.

The performance of a NACA 63-215 airfoil section under different operational co time period of one year has been studied. For the case study at hand and also for validation, operating conditions similar to those of the experimental study of Khalfal [1] were used. Khalfallaha and Koliub [1] conducted an on-site investigation for dus over the blades of a stall controlled wind turbine (Nordtank 300 kW). According t specification and site characteristics, an average Reynolds number of 1×10^6 can be the blade length with an angle of attack of 4°.

The flow field around the two-dimensional clean and fouled airfoil section (NAC
solved by numerical solution of the two-dimensional incompressible Navier-St
coupled with a turbulence model which is chosen to be SST k-ω. For validation purp
results are compared with the experimental results of Khalfallaha and Koliub [1] an
results of Ren [2]. The developed model is used to assess the effect of roughness h
on both the lift and drag coefficients.

Key words: wind turbines, dusty flow, performance deterioration.

DEDICATION

To my Dad, Sister, and Dr. Aya for always being there.

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VITA

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